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ART. I.—*On the Action of Yellow Light in producing the Green Color, and Indigo Light the Movements of Plants;* by D. P. GARDNER, M. D., Cor. Memb. Lyc. Nat. Hist. New York.

(1.) THE object of this paper is to prove the existence of different properties in the rays of the spectrum, in their action on vegetables; and more especially to show that the rays which produce the green color of plants, are altogether dissimilar from those which influence their movements towards light—the color being developed by the less refrangible rays, and chiefly by the *yellow;* whereas, the motion is influenced by indigo light. The discussion of the subject will be divided under three heads:

1. On the production of chlorophyl by yellow light.
2. On the movements of plants towards indigo light.
3. Some application of these facts to vegetable physiology.

I. *On the production of chlorophyl by yellow light.*

(2.) It is a fundamental fact in botany that light is necessary to the formation of chlorophyl. Von Humboldt adduced certain exceptions to this law, in the case of plants found in the mines of Freyberg, and with Senebier ascribed the green matter to the action of hydrogen gas. But the experiments of the latter failed in the hands of De Candolle, and a series instituted by myself, and conducted with great care, were equally unsuccessful. On the other hand, Humboldt succeeded in greening a plant of *Le-*

pidium sativum, raised in darkness, by the light of two lamps, and De Candolle obtained the same result with six Argand lamps.

(3.) The investigation has been subsequently confined to the name of the ray which produces chlorophyl.* Formerly it was tacitly admitted on the authority of Senebier that the *chemical* or blue ray was most active. Prof. Morren (Annal. des Scien. Nat., Oct. 1832) ascribed it to the luminous colors, more especially the rays which had passed through bright yellow and orange glasses. Dr. Daubeny (Phil. Trans. 1836) in his valuable researches arrived at the same conclusion. The next investigator, Dr. Draper, (Jour. Franklin Inst. 1837,) obtained better results in yellow than blue light. Mr. Hunt in 1840 (Lond. and Edinb. Phil. Mag. April) resumed the question, and published the most decided results (p. 272) to the effect, that *blue light alone* causes the green color of plants, and that the yellow and red rays, "*destroy the vital principle in the seed.*" In 1841, he was one of a committee appointed by the British Association to report on this subject, and in a subsequent conversation at the late meeting of that body, has repeated his statements. Being the last writer, his results have given a prominence to the doctrine that chlorophyl is produced by the blue rays, so as to mislead Prof. Johnston in his agricultural lectures, and Prof. Graham. (Chemistry, p. 1013.)

(4.) In September, 1840, I repeated Mr. Hunt's experiments in Virginia, and obtained dissimilar results. A known number of turnip seeds were sown, and every grain germinated in the yellow and red rays. The greenest plants were found in yellow light. Every condition was favorable, and the results well characterized, but my reason for deferring the publication arose from a conviction that the use of solutions and colored glasses was objectionable—and *that no perfect results could be obtained except with the spectrum.* Plants exposed to light which has permeated cobalt glass, are not placed in blue rays, but in red, yellow, green, blue, indigo, and violet, in proportions differing with the tone of color, and thickness of the material. The effect may

* *Chlorophyl*—the green matter of leaves. It is insoluble in water, but soluble in ether and alcohol. The ultimate analysis has not been made; but chemists agree that it is of the nature of wax. The yellow color of autumnal foliage is due to a similar yellow wax, called *Xanthophyl*, supposed to be produced by the action of frost on the former substance.

therefore be produced by any of these rays, or by their peculiar combination. (See Sir J. F. W. Herschel's paper in the Philosophical Transactions for 1840, p. 24, on "the combined action of rays of different degrees of refrangibility.")

(5.) I shall not attempt to explain the discrepancy between my results and those of Mr. Hunt, for I do not esteem researches, such as all the foregoing, made with colored media, of any value in this branch of vegetable physiology. It is well to remark, however, that in treating of the germination of cress-seed behind the blue, green, yellow, and red media, he states "that the earth continued *damp* under the *green* and *blue* fluids, whereas it *rapidly dried* under the *yellow* and *red*." (p. 271.) This difference would by most persons have been considered sufficient to retard or "destroy"? germination.

(6.) Other engagements in 1842 interfered with my design of examining this question with the spectrum, and it was not until July, 1843, that such arrangements were made as are necessary to the prosecution of the subject.

(7.) *The apparatus.*—A beam of the sun's light was directed by a heliostat placed outside my window, along a square tube of wood, passing through the shutter. The inner extremity of the tube was closed, and contained near its end a flint glass equilateral prism, one inch on the side and six inches long, with the axis adjusted perpendicularly. The dispersed light passed into the chamber, through an aperture in the side of the tube. All that portion of the beam, which exceeded the breadth of the prism, was cut off by a diaphragm. The object of these arrangements was to render the room dark. The experiments were performed in Virginia, in latitude 37° 10′ N., and continued from July 6th to October 1st, during a season of unusual brilliancy and temperature.

(8.) *Arrangements for the experiments.*—Seedlings of turnips, radish, mustard, peas, several varieties of beans, peas, and the following transplanted specimens, were used—*Solanum nigrum, S. Virginianum; Plantago major, P. minor; Polygonum hydropiper; Chenopodium rubrum; Rumex obtusifolius.* They were placed in boxes with partitions, or planted in jars and grew in darkness until ready for experiment, so that they acquired a yellow color. The number of plants exposed to each ray averaged one hundred, when the smaller seeds were used, and the

result indicated was obtained by a comparison of the whole. The age of seedlings is a matter of moment; those which are young, and from one inch to one inch and three fourths high, in the case of turnips, were most sensitive; indeed, these plants were found to give the best results, and were used almost exclusively after the first month.

The spectrum was allowed to fall on the specimens at a distance of fifteen feet from the prism, and undecomposed light shut out by screens. Each ray acted in a separate compartment, unless otherwise stated.

(9.) The following extract of an experiment, will show some farther details.

August 13th.—Five jars, containing each about one hundred turnip seedlings, were placed respectively in the orange, yellow, blue, indigo, and violet rays at 9h. A. M. *Day*, bright—temperature in shade at noon 80° Fah., in the sun 95°. Duration of sunshine 6½ hours. Result at 3½h. P. M. The third column of the table shows the altitude of the plants at the commencement of the observation.

Jar.	Light.	Height at 9h.	Result.	Order.
1	orange	1 inch	green	2
2	yellow	1 "	full green	1
3	blue	1¼ "	slight olive	*
4	indigo	1 "	yellow	0
5	violet	1¼ "	yellow	0

August 14th.—The same plants with the addition of a fresh crop (6) in the green ray. Exposure from 9h. A. M. to 3h. P. M. or six hours sunshine. Temperature in shade at noon 85° Fahr., and 105° in the sun. Result at 3h. P. M.

Jar.	Light.	Height at 9h.	Result.	Order.
1	orange	2¼ inches	full green	2
2	yellow	2¼ "	perfect green	1
3	blue	3 "	slight green	4
4	indigo	3 "	yellow	0
5	violet	3½ "	yellow	0
6	green	1 inch	fair green	3

* The fifth column contains a comparative estimate of the depth of color, assuming unity at the highest value; on this scale the plant in blue light did not become green, and the value is negative, but there was a visible alteration designated olive, and indicating the tint which vegetables assume in passing from the yellow color of darkness to green.

The leaves of 1 and 2 were developed. *Experiment* concluded after 30 hours, of which 12½ were sunshine, and 17½ darkness. The greater altitude of the plants in the indigo and violet rays—a fact discovered by Morren, is due probably to the slowness of exhalation by vegetables in those colors, an effect not of light, but of heat. In this observation, no result whatsoever was produced on the original yellow color of the seedlings in the indigo and violet rays.

(10.) The ensuing table contains the comparable points of six similar experiments. The 1st column gives the number of the observation; the 2d, the plants used; the 3d, the number of hours of sunshine; the 4th, the whole duration of the experiment; and from the 5th to the 13th column, the rays of the spectrum; the figures in the last spaces indicate only the order of color in the particular observation. The sign of minus is introduced, whenever the effect of the ray was not tested, or the result was defective.

TABLE, *showing the* ACTIVE *and* INACTIVE *rays of the spectrum, in producing the green color of plants.*

Experiment.	Plants.	Hours of light.	Total time.	ACTIVE RAYS.					INACTIVE RAYS.			
				Red.	Orange.	Yellow.	Green.		Blue.	Indigo.	Violet.	Lav'nder.
1	turnips	22	109	4	2	1	3	—	0	0	0	0
2	beans, &c.	14	95	–	2	1	3	—	0	–	–	–
3	turnips, &c.	8	69	4	2	1	3	—	–	–	–	–
4	turnips	23	101	–	–	–	1	—	0	0	0	0
5	turnips	17.5	52	–	2	1	3	—	4	0	0	0
6	turnips	5.5	6	4	2	1	3	—	0	0	0	0

In experiment 5, the blue ray produced a green color, but the usual effect was a light olive. The indigo, violet, and lavender portions were always inactive, although several observations were continued until the plants faded.

(11.) Under favorable circumstances it requires a long exposure to develope chlorophyl. The shortest period I witnessed was in a crop of turnip seedlings, which required two hours in the centre of the yellow rays, but frequently six or more hours were necessary. In the full sunshine of Virginia, it requires more than one hour to produce the same effect.

The color acquired is not fugitive. It has been observed, scarcely changed after seventy two hours' darkness, in turnips,

and seven days in beans. Plants from the field preserve their color sometimes for weeks, but finally become yellow.

(12.) The fact established by these experiments is, that the less refrangible rays are most active in producing the green color of plants. It is not stated, that the blue, &c. rays will not effect this change *in time*, but, that they are remarkably inactive.

(13.) *The maximum action is in yellow light.* For the purpose of obtaining a measure of the comparative activity of each ray, the following experiment was made. The spectrum of a circular beam of light three fourths of an inch in diameter, was received upon a double convex lens of three feet focus, placed near the prism. The dispersed rays passed through a chink of one fourth of an inch into a camera, and each fell into a separate compartment, containing a few turnip seedlings, situated near the focus of the ray. The place of the extreme red and central yellow rays was determined through cobalt glass, and the whole spectrum divided into the spaces given by Fraunhofer, for the width of each color. The arrangements being carefully adjusted, the plants were examined at intervals, by allowing a little diffused light to fall upon them, and excluding the spectrum; in this way, the number of hours was obtained in which a given ray produced a certain effect. The depth of green color was estimated, by carefully comparing the plants, with a selected specimen; in this I was assisted by a friend, whose eye is well skilled in distinguishing between shades of color.

(14.) The best result gave for the yellow $3\frac{1}{2}$ hours, the orange $4\frac{1}{2}$ hours, and the green ray 6 hours; the plants were selected from the centre of each group, and all the measures obtained on the same day during uninterrupted sunshine. The experiment was continued until $17\frac{1}{2}$ hours of sunlight had acted upon the seedlings in the blue space, which then acquired a tint estimated at one half that of the test. In another observation the indigo, violet, and lavender of Sir John Herschel produced no effect in 23 hours.

(15.) From these experiments I conclude that the *centre of the yellow ray is the point of maximum effect in the production of chlorophyl;* and that the action diminishes on either side to the termination of the *mean red* and *blue.*

(16.) In this stage of the subject, an interesting question suggests itself—is the active agent LIGHT? some form of chemical ray? or heat?

To discover whether it was due to Tithonicity,* I placed a crop of turnip seedlings in a box, illuminated exclusively with light, which had traversed a solution of bichromate of potassa, sufficiently concentrated to absorb all tithonic rays. The plants became green in about 2½ hours, so as to indicate not only, that detithonized light was capable of producing the green matter, but of doing so with remarkable activity. *Hence, the formation of chlorophyl is not due to Tithonicity.*

Nor is heat the active principle, for the maxima of heat which has traversed flint glass, do not correspond with the rays which produce the chief action on etiolated plants. *Chlorophyl is therefore produced by the imponderable* LIGHT, *as distinguished from all other known agents found in the sunbeam.*

II. *On the movements of plants towards indigo light.*

(17.) Among the most interesting phenomena of plants, is the apparent instinct of bending towards light. The character of the movement may be seen with ease, by exposing a crop of turnip seedlings near the light of an Argand lamp, provided with an opaque shade. If they be adjusted in such a manner as to leave the leaflets slightly above the lower margin of the shade, the whole will be found inclined forwards in two to four hours. It is this movement I propose to examine.

(18.) All erect plants obtained in darkness, when exposed to the solar spectrum, in distinct compartments, incline themselves forwards towards the prism. It is therefore an effect which is produced in every variety of light—even obscure light can accomplish it; therefore, in researches on this subject, every precaution must be taken to darken the place of experiment. The amount of bending frequently exceeds ninety degrees, and a movement of the free extremity of the stem through one inch to one inch and a half from the perpendicular, is not unusual in turnip seedlings.

(19.) If the young plants be exposed to a spectrum produced as in Art. 13, in a box without compartments, after a time they

* See Dr. Draper's paper in the Lond. Edinb. and Dub. Phil. Mag. for Dec. 1842. *Tithonicity* is the name of an imponderable agent, supposed to differ from light, by being invisible; and from heat, by not being conducted by metals and incapable of producing the expansion of bodies. From this term *tithonometer* and *tithonic* rays are derived.

will be found inclined diagonally towards a common axis—those in the red, orange, yellow, and green, bending towards the indigo, and the plants of the violet and lavender spaces moving to meet them. When a larger spectrum of fourteen inches was used, and the seedlings exposed for five hours, they were so inclined as to suggest the appearance of a field of growing wheat blown by two winds to a common point. If the experiment were sufficiently prolonged, some of the plants from either side of the spectrum interlocked in the direction of the axis.

(20.) *This axis is in the direction taken by Fraunhofer's indigo ray in passing from the prism to the plants.* The seedlings growing in indigo light inclined directly along it; but those of the red and orange did not move towards the radiant in the prism, but along a diagonal, inclined in part towards the plants illuminated by the active rays, which were much nearer than the prism. The amount of this lateral inclination diminished as the plants were nearer the axis, so that those illuminated by blue, violet, and lavender, were little deflected from a line drawn from their place of growth to the radiant. Seedlings in the red, orange, and yellow rays, frequently bent to such an extent, as to cause their summits to pass through the adjoining colored space.

(21.) The secondary (lateral) inclination did not occur when the radiant was a reflected image of the spectrum, which was not allowed to fall on any of the plants. If the mirror reflected neither of the more refrangible rays, the plants appeared to be inclined to the light immediately before them.

(22.) These experiments satisfied me that the active force was in the indigo ray, and the intensity of the light necessary to produce deflection was extremely feeble, so that an amount inappreciable to the eye, which is an admirable measure of the intensity, but incapable of estimating the effect of quantities, would after a lengthened exposure, cause considerable deflection. Indeed the phenomenon is so little dependent on the brilliancy of light, that very little seems to be gained by concentrating the rays beyond a certain point. There is sufficient activity in each prismatic color to produce bending, if enough time be allowed. The movement is therefore a result depending upon the absorption of light.

(23.) As this is an entirely new subject, it is thought expedient to advance some further evidence concerning the position of

the deflecting force. For this purpose, the spectrum was allowed to fall upon a screen, perforated by two similar apertures, in such positions as to allow the red ray to pass through one, and the indigo through the other. Behind the screen, a box was placed containing four jars of turnip seedlings, arranged along a line occupying the centre between the intromitted rays. The light passed through the box without any reflexion, and was stifled by black cloth when it reached the further extremity. All the plants commenced bending in a short time, and in two hours the nearest group were inclined forwards 90°, and laterally 50° towards the indigo aperture, the edges of which formed the radiant. In three hours, the second crop exhibited the same movement, and so with the plants of the third and fourth jar. At the conclusion of the experiment in six hours and a half, all were bent forward at about 90°, and each group inclined towards the indigo aperture, in a direction indicated by drawing a straight line from the plants to the radiant. Not one plant inclined towards the red ray, although half the collection were at first nearer to it, than to the more refrangible light.

With similar arrangements the yellow, orange and green rays were contrasted with the indigo; and always with the foregoing result. The time necessary to develope a satisfactory lateral inclination from the green rays, is greater than in the experiments made between the less refrangible rays, and indigo.

(24.) The same results were obtained when the radiants were reflected images. The extent to which the influence of the active light is felt was frequently surprising; in some of the observations pea plants were situated four feet from the indigo, and within half an inch of the yellow, red or orange radiant, notwithstanding which, they inclined towards the indigo. In these researches, the mirror was so situated as to reflect no prismatic light upon the plants.

(25.) That no doubt may rest, on the place of the soliciting force, another arrangement was used. The instrument figured by M. Pouillet, (Elemens de Phys., &c. t. 1, fig. 218,) for examining the effect of combinations of rays of light in producing color, was taken. Red rays were received on one mirror, and indigo on another, and the two so far inclined as to cause the rays to intermix at a place about three inches in advance of the instrument, and out of the incident beam. A jar of turnip seedlings was then

placed so as to receive the compound light in its centre—the plants being illuminated in part by the red, indigo and purple rays. In two hours the movements were considerable, and somewhat complex. Every plant lighted by the indigo rays, was inclined directly to that radiant. Those which received red light, were bent to the central purple, and none to the red radiant. But many seedlings at first in the red, inclined themselves towards the purple, and after being fully illuminated thereby, commenced a lateral movement towards the indigo radiant, so that, at the close of the experiment, their stems exhibited two inclinations, one in a vertical, and the other in a horizontal plane.

(26.) Plants raised in darkness, as well as those which were green, were used in the preceding observations—but the sensibility of the former greatly exceeds that of the latter. Indeed, plants that have been exposed to light for several days, become sluggish in their movements, and the phenomenon probably ceases in parts which are ligneous. In the seedlings submitted to examination, the movements were found to take place, in consequence of an action impressed upon the stem only, for the removal of the leaflets did not alter the result. A still more remarkable fact was discovered in all the cases observed—that after complete bending, plants erect themselves again, when placed in darkness, at least in situations so dark, as to appear entirely deprived of light. This effect is best seen in seedlings which have never been exposed to the direct rays of the sun; for, after full and lengthened exposure, it diminishes almost to zero. The action of light in producing movement, seems therefore to be transient, that is, it is not accompanied with a permanent change of structure in the stem.

(27.) From all the foregoing experiments, it is demonstrable—*that the force, which constrains the movements of plants towards light, has its maximum in the indigo ray.*

(28.) But the solar beam contains a number of agents, one of which more especially developes itself in this part of the flint-glass spectrum, acting upon argentine compounds with great effect. Dr. Draper has discovered the existence of chemical action, distinct from the rays of light, or heat, throughout the spectrum, and terms the agent which produces it Tithonicity. Is the bending of plants produced by the *tithonic rays?* by *heat?* or by LIGHT?

(29.) The investigation of these important problems has cost me much labor, but the following results will show, that a satisfactory solution has been attained.

A trough of plate-glass, containing persulphocyanide of iron, which has the property of absorbing the tithonic rays of the indigo space, and allowing indigo light to pass, was placed before a small aperture, made in the side of a suitable box. The proper place for the hole, was determined by receiving the analyzed spectrum on a Daguerre plate, resting against the box. In a few minutes, two stains were observed, with an interval between them, corresponding to the place of the indigo light. The inactive space was marked on the wood, and a perforation made in its centre, without deranging the adjustment, so that the aperture continued to admit detithonized light. Plants placed in this box were bent in two hours, whilst a crop illuminated by indigo rays, which had not been transmitted through the solution, did not move with much more activity, although one crop was exposed to the maximum of the indigo tithonic rays, and the other placed in detithonized light.

(30.) Solution of bichromate of potash, intercepts nearly all tithonic matter, but permits the free passage of luminous rays. A crop of turnip seedlings was introduced into a box and illuminated by the yellow rays of the spectrum, analyzed by this solution. A Daguerre plate was also introduced, to serve as a test of chemical action. In two hours and a half the plants were all equally bent, and the plate but slightly stained on one edge. A group of similar plants exposed in the same place, without the solution, were inclined in a period of time not materially different. If the bending had been due to tithonicity, the seedlings should have moved towards the place where the silver was stained.

(31.) The tithonic activity of rays transmitted through the above solution, from an Argand lamp, is diminished to less than one two-hundreth part, as measured by Dr. Draper's tithonometer.* But plants were bent in light from this source which had traversed the solution, in a period of time not much greater than that required in the full blaze of the lamp.

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* *Tithonometer*—an instrument for measuring the chemical force of rays, by the union of chlorine and hydrogen.

This result alone, is abundantly sufficient to decide the question, and show the total inactivity of the tithonic rays in producing these vegetable movements.

(32.) That the bending is not due to heat, appears from the following considerations. The action is greatest in those parts of the spectrum which give evidence of least heat. The axis is approached on one side by plants from the red, orange, yellow and green, and by those from the violet and lavender on the other, which is a phenomenon, altogether inexplicable on the supposition, that heat is the active agent.

Plants shut from the light of an Argand lamp, by a plate of copper foil, do not incline to the warm metal.

Finally, the moonbeams, even without condensation, are capable of producing extensive bending, in one or two hours. This result is conclusive of the question, for no trace of caloric can be found in the moon's light.

(33.) As far, therefore, as the presence of heat can be determined by thermoscopes, or the tithonic rays, by argentine compounds, and the union of chlorine and hydrogen, we are justified in concluding that the movements of plants are effected by a totally different agent. LIGHT *only, remains in the spectrum, so far as we know, and to it, therefore, I refer the motions under consideration.*

(34.) This conclusion is of deep interest, inasmuch as *it is the first case of a movement, perceptible to the eye, being traced to the unaided action of light.* That this imponderable produced molecular changes was readily admitted, but its influence in bringing about palpable movements of considerable extent, has never been suspected. In the irritability of the *iris*, physiologists have always seen the influence of nervous matter; but in plants no such agent exists to complicate the phenomenon, and therefore the action is due to light only.

In this newly discovered property, light is also more closely assimilated to the other imponderables—for both heat and electricity are capable of producing palpable motion.

III. *Some applications of the preceding facts, &c.*

(35.) Numerous applications to vegetable physiology will suggest themselves to the reader, but it is my purpose to treat only of the following.

The intimate relation which exists between the rays which produce chlorophyl, the decomposition of carbonic acid, and the luminous spectrum. The maximum for the formation of green matter, has been shown to reside in the yellow ray. Dr. Draper (Lond. and Edinb. Phil. Mag., Sept. 1843) discovered the maximum action, for the decomposition of carbonic acid, to be between the green and yellow, or more correctly, in the centre of the yellow. Sir W. Herschel and Fraunhofer placed the maximum for light in the same space.

(36.) The relation goes further; for if the quantities obtained by Dr. Draper for decomposing action, as measured by liberated gas—Fraunhofer for illuminating power, determined by the eye—and my estimate, obtained in time and by the eye—be rendered commensurable and tabulated, they will give quantities nearly allied. To produce such a table, I assume all the maxima equal to unity. My results being in *time*, and theirs in *effect*, the inverse proportion is taken for each value given in Art. 14.

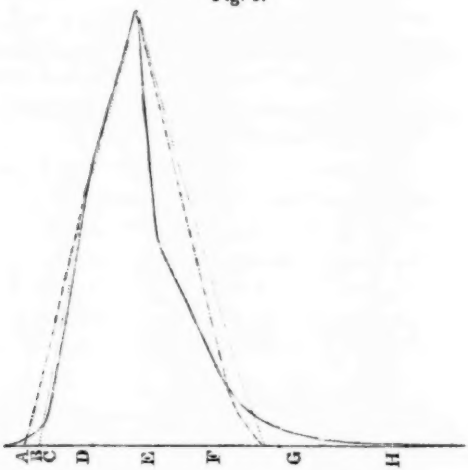
TABLE *showing the force of the solar rays, in producing the green color of plants, the decomposition of carbonic acid, and illumination.*

Places examined.	Production of chlorophyl.	Decompos. of carbonic acid.	Illuminating power.
Extreme red, ...	0.000	0.0000	0.0000
Line B, ...	. .	.0091	.0320
Line C, ...	. .	. .	.0940
Commencement of orange,	. .	.5550	
Line D, ...	. .	. .	.6400
Centre of orange, . . .	.777		
Centre of yellow, ...	1.000	1.0000	1.0000
Line E, ...	. .	. .	.4800
Centre of green, ...	.583		
Line F, ...	. .	. .	.1700
Centre of blue, ...	.100		
End of blue, ...	. .	.0027	
Line G, ...	0.000	0.0000	.0310
Line H, ...	0.000	0.0000	.0056

Upon projecting these numbers, which although not rigorously correct are very good approximations, the unity of the active agent will be more strikingly exhibited. Let the axis of abscissas be divided into intervals corresponding to Fraunhofer's colored spaces, and the positions of the mean places of the dark lines be marked from Mr. Powell's recent work on dispersion.

The ordinates are from the table. Fraunhofer's estimates are indicated by a bold line, Dr. Draper's by dots, and my own by an interrupted line, fig. 1.

Fig. 1.



Had more points in these figures been determined, there is no doubt they would have coincided precisely. It is not to be forgotten, that these results were obtained in places many hundred miles apart. They determine, what hitherto has only been conjectured, that the greening of plants, and decomposition of carbonic acid, are produced by the same agent—which is also the active imponderable in producing vision—a phenomenon in no way similar, as suggested by M. Möser, to the change of Daguerre's plate, which is a tithonic action. The dependence of the depth of green color in foliage, upon brilliant light, is also shown. The statements of travellers, in respect to tropical vegetation, confirms this conclusion.

(38.) Chlorophyl, the body generated in the yellow leaflets of plants, raised in darkness, by the action of light, is a hydrocarbon, of the nature of wax. Whether it be produced by decomposition of carbonic acid, or be the yellow matter, or some other substance, as dextrine, already present in the leaf, which has suffered deoxidation, is altogether unknown. The latter view, applied to the formation of oils, and fats in animals, by Liebig, is probably correct—by adopting it, we are relieved from all difficulty in regard

to the supply of hydrogen, in plants; for the evidence, that water is decomposed in their structures, is by no means conclusive. In the formation of oils in seeds, it is known that the deoxidation of sugar occurs; for we have the liberation of carbonic acid from the petals, &c. and a destruction of the organic matter.

Subsequently to the production of chlorophyl, carbonic acid is decomposed by light, and this function, directly or indirectly, is sufficient to generate all organic matter. Hence the existence of all organic matter is due to the LIGHT of the sun.

(39.) *On the destruction of chlorophyl by light.*—The production of green matter, by the yellow rays, leads us to infer its destruction by the blue and red. Sir J. F. W. Herschel (Phil. Mag. Feb. 1843) found that the expressed juices of leaves are acted upon by the spectrum, with much uniformity. In the case of elder leaves, (fig. 8,) there was a strong maximum, producing a nearly insulated solar image at −11.5, of his scale,* or nearly at the end of the red rays—the action thence was feeble, with two minima at −5.0 and +6.8, with a slight intermediate maximum at (0.0) the centre of the yellow, and beyond these, or about the termination of the green, the action again increases, reaches another maximum at +20.0, which corresponds to the centre of Fraunhofer's indigo, after which it declines to a point beyond the violet +45.0.

I have been thus precise in giving his result, because my experiments made with ethereal solution of chlorophyl from grass leaves spread upon paper, gave similar spectra. There are two points, however, which it is necessary to discuss.

The first action of light is perceived in the mean red ray, and it attains a maximum incomparably greater at that point than elsewhere—the next place affected is in the indigo, and accom-

* By proceeding as in Art. 13, a spectrum is obtained which has only the width of the focal picture of the sun, and is of considerable length; these elements differ, however, with the focal distance of the lens. Upon examining such a spectrum through cobalt glass, a perfectly circular image of the sun is seen at the extreme red end, another in the centre of the yellow, and the termination of the violet is sharp and distinct. Sir John Herschel takes the centre of the yellow thus insulated as his zero point, and using a scale of thirtieths of an inch divides the distance between it and the red end into negative parts, and in the direction of the violet positively. The spectrum he used contained 13.30 negative, and 40.62 positive parts, and was therefore $\frac{53}{30}\frac{92}{}$ inches long. My spectrum corresponded with this very closely.

panying it, there is an action from +10.5 to +36.0 of the same scale, beginning abruptly in Fraunhofer's blue. So striking is this whole result, that some of the earlier spectra obtained by me, contained a perfectly neutral space from −5.0 to +10.5, in which the chlorophyl was in no way changed, whilst the solar picture in the red was sharp and of a dazzling whiteness, and the maximum of the indigo was also bleached—producing a linear spectrum, as in fig. 2, in which the orange, yellow and green rays are inactive; these it will be remembered are energetic in forming the green matter.

Fig. 2.

Red, orange, yellow, green, blue, indigo, violet.

Upon longer exposure, the subordinate action along the yellow, &c. occurs, but not until the other portions are perfectly bleached.

In Sir J. Herschel's experiments there remained a salmon color, after the discharge of the green. This is not seen when chlorophyl is used, and is due to a coloring matter, insoluble in ether.

(40.) No ground exists therefore for the theory that the autumnal tint of leaves is due to the residual, after the destruction of the green color. Xanthophyl, which imparts the yellow, depends on an organic change of chlorophyl, which Berzelius could not imitate. (Journ. de Pharm. Juillet, 1837.)

Some observations made with a view of determining the action of indigo light on the green of living plants, brought me to the conclusion, that it faded into a yellowish green color—but I will not speak positively. Plants do, however, lose all their greenness in a dark place, after a greater or less time, and become of the color of seedlings raised without light. In this result my experience is at variance with the statement of Macaire Princep, "Les feuilles d'une plante conservées à l'abri de la lumière s'en detachent colorées vert." (In Berzelius, Chimie, t. 6, p. 42; from Mem. de la Soc. Hist. Nat. de Geneve, t. 4.)

(41.) In the *bleaching of chlorophyl*, as well as in its production, *the active agent is* LIGHT, for it will take place behind a medium excluding the tithonic rays, and the points of activity have no relation to the maxima of the calorific spectrum. See Sir John Herschel's paper, (Phil. Trans. 1840, Part I, p. 51,) "on the distribution of the calorific rays of the solar spectrum."

(42.) The coincidence shown to exist between the illuminating power, activity of decomposition, and greening effect of yellow light, is conclusive of the discussion respecting the rays which are favorable to the growth of vegetables. Blue light cannot be the best, as originally affirmed by Senebier, and subsequently maintained by Mr. Hunt—nor would a conservatory glazed with cobalt glass answer the expectations of Professor Johnston.

(43.) It is impossible to conclude, without calling the attention of physiologists to the remarkable fact, proved in the second part of this paper—that *indigo light* possesses a soliciting power, capable of governing the direction of the stems, peduncles, &c. of plants; an action accomplished by light incomparably feeble in comparison with the yellow rays. The blue of the atmosphere is scarcely less intense, when compared with the sun's beams. *Does not the color of the sky, therefore, regulate the upright growth of stems to a certain extent? Is it not in virtue of the soliciting force therein, that plants continue to grow erect, whenever other disturbing forces are in equilibrio?* These questions might be investigated with profit, were not this communication too extended already.

(44.) It is proper to state, however, that De Candolle's theory of the bending of plants towards light, has been fully disproved in the context,* in as much as it is effected by the indigo rays which have not power to decompose carbonic acid and produce lignin, &c. (See *Mem. Soc. d'Arcueil*, 1809, *p.* 104.)

In conclusion, it appears that the following facts have been established.

1st. That chlorophyl is produced by the more luminous rays, the maximum being in the yellow.

2d. This formation is due to pure LIGHT, an imponderable distinct from all others.

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* De Candolle advanced a theory to account for the bending of plants towards light, on the following grounds. That as the side of any plant nearest the light was acted on thereby, whilst the distant portions were unilluminated, carbonic acid would be decomposed, and lignin, &c. produced on one side, and not the other. The plant becoming firmer on the part thus furnished with woody fibre, bent over towards the luminous source.

3d. That the ray tov ds which plants bend occupies the indigo space of Fraunhofer.

4th. This movement is due to pure LIGHT as distinguished from *heat* and *tithonicity*.

5th. *That pure* LIGHT *is capable of producing changes which result in the development of palpable motion.*

6th. The bleaching of chlorophyl is most active in those parts of the spectrum which possess no influence in its production, and are complimentary to the yellow rays.

7th. This action is also due to pure LIGHT.

We have, therefore, an analysis of the action of every ray in the luminous spectrum upon vegetation. The several effects produced are not abruptly terminated within the limits of any of the spaces, but overlap to a certain extent, a fact which coincides with our experience of the properties of the rays. Whilst *heat* and *tithonicity* are capable of causing the union of mineral particles, *light* appears to be the only radiant body which rules preeminent in the organic world. To the animating beams of the sun we owe whatever products are necessary to our very existence.

New York, Oct. 18th, 1843.

ART. II.—*Remarks on Zoological Nomenclature;* by S. S. HALDEMAN, Professor of Zoology in the Franklin Institute, Philadelphia.

IT is gratifying to perceive with what unanimity certain rules, tending towards an uniformity of practice on this subject, have been adopted, by naturalists of different countries. The basis of these is undoubtedly the *practice* of Linnæus; but Smith, Willdenow, Swainson, (Cab. Cyc. *Birds*, p. 231,) Illiger, and Rafinesque, by special rules; and other naturalists by custom, have enlarged the original code as additions became necessary.* The laws laid down by the British Association, being founded upon modern practice, contain little that can be objected to; and

* The Academy of Natural Sciences of Philadelphia has decided that the author to whom a species originally belongs, is entitled to the citation of it, in whatever genus it may be subsequently placed by others; and that the reading of a paper before a society, does not constitute a publication.

the committee that framed them were evidently conscious that they were laboring, not for their countrymen alone, but for the scientific world at large; and those laws are undoubtedly the best, whose authority will be admitted by the greatest number of authors interested.

This Dr. Gould (Vol. XLV, p. 10 of this Journal) appears to have overlooked, in his excellent remarks on the subject, or he would probably not have demurred to the requisition that specific names should have a small initial letter. The committee (general convenience out of the question) evidently saw the impropriety of imposing the partial practice of their own vernacular upon a language used to a great extent in other lands, where no local practice would be admitted. We know it to be customary in Germany and France, to commence all adjectives with a small letter; whilst in English, many words derived from persons and places follow the same rule.*

If no distinction be made in favor of personal names (universal consent being, in this instance, more important than classical precedent,) it will have a tendency to discredit the practice of commemorating every collector with a species. Nor do I think so lightly of the objection that isolated generic and specific names may be confounded. Mythological names are used in both ways to a great extent, many generic names are pure adjectives, and many specific ones have been raised to generic, so that the distinction indicated by the initial letter, becomes of great service. The following are a few of those used both in a generic and specific sense:—*rupicola*, *spectrum*, *aotus*, *microstoma*, *chromis*, *cynocephalus*, *molossus*, *glaucus*, *gobio*, *calceola*, *crabro*, *trochilus*.

The practice was introduced here twenty-five years ago, of writing personal specific names without a declensional termination, and a few authors appear disposed to revive it. Thus we have *Squalus cuvier*, Les., *S. spallanzani*, *Squatina dumeril*, and perhaps *Chama lazarus*. This, with the genitive *merilii*, the adjective *merilina*, *spallanzanæus*, gives us three forms for a personal specific appellation,† and I see no particular objection

* As galvanic, galvanism, calvinism, delphic, transatlantic, congreve-rocket.

† As in English, we can say, the Washington monument, Washington's monument, or the monument of Washington.

to either. The first form is not objectionable, as our modern names are properly indeclinable, and the addition of a Latin syllable does not convert them into Latin words.

Whether generic and specific names should be inflected or not, must be left to future practice. An opinion appears to obtain that they may be considered indeclinable, as we seldom see them employed, except in their usual form; so seldom, indeed, that we are quite strangers to the plurals used by the older authors, as Gilbert White's *Hirundines rusticæ*, *Hirundines apodes*, or *Motacillæ trochili*. Many generic names are difficult to decline; the rapidity of composition does not allow time for examination, and some respectable naturalists have not had a classical education; besides, many names are not in the dictionaries, and have no corresponding rule in the grammars.* Some authors would much rather reconstruct sentences, than attempt to inflect words of the following character: Alligator, Selache, Gecko, Schilbe, Malthe, Mene, Halicore, Erato, Ammonceratites, there being a choice between four terminations for the last, including *ceras*, *cera*, and *cerus*.

If the strictest justice to antecedent authors cannot be obtained by practice, it must be enforced by rule. Number 3 (p. 4) has a partial bearing upon this point, but it requires the addition . . . *with the citation of the original authors.* Some of the Linnæan genera have been drawn upon so largely, that there is literally nothing left. It might be supposed that such genera as Simia, Buprestis, and Lepas, had never been formed, and with the genus, many authors do not hesitate to appropriate the species by self-citation; and as probably no genus or group can stand exactly as the great master left it, *his* name must ere long be blotted from the system which owes to him its existence. The rule as it stands will be of little use, if we are permitted to write Perca, *Cuv.* instead of Perca, *Lin.* It may be said that the genus of Cuvier is not that of Linnæus—perhaps not; but if the former be entitled to it on this account, then is he also entitled to the species; because, although Linnæus had a *Perca fluviatilis*, it is not quite the fish so named by Cuvier, as it does not belong to the same genus!

* Is *Juli* a singular or plural, genitive or dative? is it from *Julus* or *Julis*? is the latter masculine or feminine, declined like *turris* or *lapis*, should the initial be I or J?

Let us examine this pernicious practice a little further. Lamarck first framed and characterized the genus Ampullaria. Sowerby gave it a different extent by adding the *cornu-arietis*, and would thus have been entitled to it until it appertained to Guilding* by the withdrawal of the same species to form his genus Ceratodes, although this removal restored the genus to the Lamarckian standard. The right of possession, however, is not recognized under barbarian laws; consequently, the discovery and withdrawal of Ampullacera entitled Quoy to the spoils, until they fell into the hands of Swainson by the restoration of Montfort's deposed genus Lanistes; but as it is uncertain whether this should or should not have been done, and as the reigning authority must differ according to the different views entertained of the succession, added to the uncertainty attendant upon revolutionary proceedings, the genus Ampullaria has fallen into a state of anarchy, without authority or patron, the prey to dissentient claimants; and all this after it had been clearly established by Lamarck, who still lives in his works, and in the grateful remembrance of those who appreciate his merits. He is still cited for his genus, but this toleration will be revoked the moment it is conceded to be just to assume the original genus, as well as the subdivisions, when it becomes necessary to divide a group. Some authors appear to possess a monomania on the subject of having their names attached to the species of antecedent authors, undisturbed by the thought that the time may come when every species will be so well known as to require no citation, and the names of the proposers of species of almost as little account as the lists in a city directory.

It would be well perhaps, to add a section to rule 10, (p. 4,) as follows:—*But the author who merely proposes the change, like the corrector of a typographical error, is not entitled to the citation of the genus and species.* If the original author be not entitled to it, it belongs to the world at large (*autorum*). If this rule could be adopted, or depended upon by describers, the deluge of personal and geographical names would be stopped, as they are imposed from the fear that any suitable adjective may have been already (perhaps simultaneously) appropriated in some other portion of the world. It appears an injustice to those who

* It is not material to my argument whether he or Quoy has priority.

give the best names, that they are liable to lose the slight reward for their labors indicated by a citation, through circumstances beyond their control; whilst the very worst compounds secure the species to their proposers. Why should not an equal security be guarantied to all? Ex. 1. Mr. Hentz described a species of Cicindela, the name might become *C. hentzii*, Autr., although the change was proposed by Dejean. It would subserve a good purpose to restrict the genitive to these cases. The original authority might be cited with a mark (*op.*) indicating that he was the first to publish it in a work, as a species. Ex. 2. The specific name was pre-occupied in Say's *Sciurus macrourus;* Godman, on this account, changes a letter and preserves the old citation, *S. macroureus*, Say. Ex. 3. *Haltica* and *Dyticus* are preferable to *Altica* and *Dytiscus*, but the original citation must stand under either form. *Hemiramphus erythrorhynchus*, Lesueur, belongs to this author, notwithstanding his name stands *erythrorinchus.*

"14. *In writing zoological names, the rules of Latin orthography must be adhered to.*" This has been much neglected, as we find generic and specific names in use, which cannot be represented by the Latin alphabet. A name should not be adopted which cannot be Latinized, or put into an unobjectionable shape. The double *n*, as it occurs in English and German, is inadmissible in Latin; thus Linnæus, Fabricius, and Degeer wrote *pensylvanica*, otherwise, many readers may suppose the *n* to be double, in pronunciation. *Goodenia*, *Goodenoviæ*, are faulty, because the *oo* brings a redundant syllable. *Gudenia* is preferable. Of those cited by Dr. Gould (p. 10) *Le Guillouii* is certainly indeclinable, the *article* is inadmissible, and if Guilloüs be the assumed nominative, *Guilloï* is probably less objectionable. So *Petituarsii* is less unsightly as a Latin word than *Dupetit Thouarsii. Eschscholtz* is invincible, nine consonants to two vowels being beyond the power of the language, and no genus should be admitted which cannot be pronounced with the ordinary power of the alphabet; otherwise Chinese characters may claim a place at some future day. The next rule is based upon recent precedents.

If A describes a new object, and B renames it without reference to what A had done; he is not entitled to the citation, even should the first name happen to be preoccupied. Because B

with less information, would possess an advantage over A, or get an advantage by an accident. Ex. 1. *Buccinum plicosum*, Menke, is *Fusus cinereus*, Say, whose specific name is preapplied. Ex. 2. An English compiler of juvenile books on natural history, ambitious of shining in a wider field, and unable to discover anything new, changed the name of several British birds. One of these was not what he supposed, but happened to be a new species; detected as such, and subsequently published by an English naturalist, who must be cited for the species. Ex. 3. An English naturalist arbitrarily changes what he supposes to be the settled name of an African bird; a French author subsequently discovers that it is a new species, proposes the published name of his predecessor, under his own authority, and is undoubtedly entitled to the species.

Vernacular names should be entirely discarded, and never quoted. Vulgar names are confined to single countries, districts, and languages; they cause great confusion, and are a source of continual annoyance to the foreign reader. An author thoughtlessly writes a paper on the identity of the *red* and *mottled owls;* the native reader knows the species, but will the dictionary of the German who reads English, give him the meaning of *mottled owls?* An English reader of a German magazine may find a paper on *Die gemeine Grasmücke* (literally, *the common grass gnat,*) and pass it, not being interested in dipterology, but turning to his German-English dictionary, which happens (an unusual circumstance) to contain the word, finds it to mean *hedge-sparrow*, which is one thing in America, another in England, and a third perhaps, in Australia. But as the authors of German-English dictionaries do not understand natural history, the *Grasmücke* is a very different species from what those who speak English call *hedge-sparrow.* So the bird *Müllerchen* (little miller) might be mistaken for the insect called *miller*, and the dictionary does not contain the word.

Many of the living naturalists of the last century, by the use of vulgar names and synonyms, render their productions unintelligible to more modern authors; and unfortunately, some of the latter have fallen into this error. The edition of the *Règne Animal* now publishing, (which the editors consider it would be "une espèce de sacrilège" to correct,) says: "Les *pagres* diffèrent des *daurades*," etc. and cites "le pagre de la Méditerranée,

(*Sparus pagrus*, Lin. Arted.)" leaving the reader to discover the modern name of *Sparus pagrus*, Lin., in a work written with more extended views. In the modern *Atlas* to the same work, the editors shamefully subvert one of the best principles of modern nomenclature. A figure of a true *Mergus* is given on plate 100, as an example of this genus, whilst our *Colymbus glacialis* is named on plate 88 "Grand plongeon (*Mergus glacialis*, Brisson,)" *Podiceps cornutus*, as "Grebe (*Colymbus cornutus*, Brisson,)" and *Gryllotalpa vulgaris*, as "La courtilière commune (*Gryllus grylio-talpa*, Lin.)" The French names take precedence in capitals, to indicate that they comprise all that is necessary.

To cite authors correctly, the name particularly adopted must be quoted, and if this be in the vernacular, conspicuously heading the description, or engraved upon the plate, the author must be cited for it; but as no one is compelled to cite unrecognized names, such works are liable to remain unnoticed. Yarrell's British Fishes cannot be cited, as he gives no systematic name to the species, and those of other authors are placed as synonyms.

To frame an unexceptionable set of rules, requires the joint labor of from three to six practical naturalists who have written creditable works; each one to be of a different nation, that local prejudices might be avoided. A single author of judgment might, by correspondence, arrive at the state of opinion on the subject, and if his geographical position were such as to throw him into communication with authors of different nations and feelings, he would be the more able to reconcile conflicting views. The varied attainments of Professor Agassiz seem to fit him for such a task, and with the assistance of the Rev. L. Jenyns in England, Fischer de Waldheim in Russia and Germany, C. L. Bonaparte in Italy, and Guérin-Méneville in France, could produce a standard *Codex zoologicus*.

ART. III.—*Mineralogy of New York—comprising detailed descriptions of the Minerals hitherto found in the State of New York, and notices of their uses in the Arts and Agriculture;* by LEWIS C. BECK, M. D., Prof. of Chem. and Nat. Hist. in Rutgers College, N. J. pp. 536 4to, with numerous wood-cuts and lithographs. Albany, 1842.

THE volume before us is one from the series of reports, published by the State of New York as the result of the late scientific survey. The extent of the state and the variety of its rock formations, give unusual interest to its scientific history, and especially to its mineralogy and geology. So large a proportion of American minerals are numbered among its productions, that the report by Dr. Beck may be considered a national rather than a state work; and the satisfactory manner in which the subject has been handled, renders it an highly important book of reference for the American mineralogist.

Prof. Beck has treated *first*, of the *economical mineralogy* of the state, giving the results of his observations upon the mineral productions useful in the arts: next, in part *second*, he has given a *descriptive account of all its mineral species*, together with detailed notices of their localities and associations. To this is added a short notice of other American minerals, not yet discovered in the state. Our remarks upon Prof. Beck's report will consist principally of facts cited from the work.

The mineral resources of New York are peculiarly well calculated for permanent prosperity. She has her mines of iron, lead and manganese—inexhaustible stores of salt in her salines—marble, abundant, and of many kinds—building material in profusion—limestone for common and hydraulic cement—clays for brick and pottery—and agricultural advantages unsurpassed in the eastern portion at least of our country, with the means at hand in her beds of gypsum, limestone and marl, for perpetuating the fertility of her lands. Excepting coal, which abounds in the adjoining states, she possesses all those important products which afford to the people sure and substantial means of industry and wealth.

Iron ores.—The beds of iron ore are inexhaustible, and are distributed in almost every county; the magnetic, specular, argillaceous and hematitic ores are all abundant, and are largely worked.

The magnetic ore however is most extensively diffused and most highly valued. It abounds in the counties of Essex and Clinton on the north, and Orange and Putnam on the south. The specular iron "is found exclusively in the northern part of the state, principally in St. Lawrence County, where it seems to take the place of the magnetic iron, which prevails in the adjoining counties." The argillaceous ore, a lenticular variety, is described as constituting two distinct parallel beds in the western part of the state, extending from Herkimer near its centre to the Genesee River. The beds are usually about twenty feet apart, and one to two and a half feet thick. The brown hematitic iron ore, or Limonite, is mostly confined to Dutchess County, where it appears to be "a part of the great series of deposits which has been traced with little interruption in a nearly northerly direction through the states of Connecticut, Massachusetts and Vermont." —p. 53.

The beds of magnetic iron are some of the most remarkable in the world. The Stirling mine in Orange County covers a surface of more than thirty acres, and the whole deposit of ore is supposed to be full three miles in length; and this is one of a number of equal extent in this county, and others to the north. The ore from the Stirling mine affords about 50 per cent. in the blast furnace; and that from Long mine, in Orange County, affords 62 per cent. of iron in the large way.

The "steel ore" of Duane, Franklin County, was examined by Dr. Beck, who found it no way different from common magnetic iron; and he expresses his doubts whether the steel obtained from it is sufficiently uniform in texture for good cutting instruments.

The specular iron ore of the Kearney and Parish ore beds, St. Lawrence County, yield about 50 per cent. of pig iron, "about twenty six hundred pounds of which yield a ton of wrought iron. The quality of the iron is improved by adding bog ore."

The lenticular or argillaceous ore yields from 30 to 35 per cent. of pig iron, which is mostly used for large castings. Prof. Beck remarks that the result is improved by mixing with the ore, bog or magnetic iron. It generally effervesces freely with an acid, indicating the presence of carbonate of lime. A specimen from Wolcottville afforded Dr. Beck, peroxyd of iron 51.50, carbonate of lime 24.50, carbonate of magnesia 7.75, silica 6.00,

alumina 7.50, moisture and loss 2.75. This ore is said to require a higher heat and one third more charcoal than other iron ores.

The hematitic iron of Dutchess County, occurs according to Mr. Mather, in beds situated near the junction of the mica or talcose slate with the gray and white limestone. The Amenia ore bed furnishes about five thousand tons of ore annually, and yields on an average 50 per cent. of pig iron.

"The manufacture of iron was commenced, in the State of New York, at a comparatively early period. It was actively carried on in Orange County for several years previously to the American Revolution. I have, however, no means of determining the extent of the manufacture at that early date. In 1810, the value of the iron manufactured in the state was estimated at $859,895. At that time there were in the counties of Essex and Clinton, one bloomery and twelve forges, at which 259 tons were manufactured, besides 100 tons from the furnaces.* In 1830, the number of iron-works and trip-hammers in the state was 335, of which the Fourth and Fifth Senate Districts contained no less than 176. According to the census returns made in 1835, the number of iron-works and trip-hammers was 434, and the value of the iron manufactured was $4,713,530; being an increase from 1830 of nearly 100 iron-works and trip-hammers, and in the value of iron manufactured of upwards of $1,000,000. In 1840, according to the census returns, there were 306 furnaces, bloomeries, forges and rolling mills; in which 82,654 tons of cast iron, and 58,275 tons of bar iron, were manufactured. The capital invested in these was estimated at $2,113,818. To this should be added $1,806,638, as the value of hardware, cutlery, &c. manufactured."—p. 38.

Dr. Beck states that on account of the rude methods of working the ores, the iron trade has not been as profitable or flourishing as might have been expected. The ores are as good and as abundant as could be desired, and nothing but proper system and the improved modes of smelting are necessary for the most complete success. The continued use of the common forge, as Prof. Beck states, is bad economy, often losing one half the product that a well constructed furnace would afford. The recent substitution of anthracite for charcoal in blast furnaces bids fair

* Tench Coxe. Statement of Arts and Manufactures in the United States.

to be a most valuable improvement, especially as charcoal is giving out in some portions of our iron country.

Lead ores.—The only deposits of lead ore which are worthy of special mention are the veins of Rossie in St. Lawrence County and of the Shawangunk Mountains in Sullivan County. These have already been described in this Journal, and we need not repeat in this place. We cite a few sentences from Dr. Beck with regard to the condition of the Shawangunk mines.

"The mining operations have been carried on in the most judicious manner, all the galleries and levels being susceptible of complete drainage and ventilation. The amount of ore obtained is large, and it is quite probable that it may be increased to any extent, and at a trifling cost. The mineral was reduced in a reverberatory furnace; and the lead, of which many tons have been manufactured, is said to have been of good quality. Both the lead and the ore yield by cupellation a small proportion of silver; too small, however, to warrant the separation in a large way.

"The ore itself, aside from the associates above named, is as rich, as valuable, and as easily reduced, as that of any lead mine whatever. The location of this mine, too, and the prospect of a supply of ore, are all as favorable as could be desired, while the average quantity of ore in a cubic yard of the vein is as great, if not greater, than that of any lead mine at present known in the state.

"The Sullivan and St. Lawrence mines may be thus briefly contrasted. In the latter, the ore is in small veins, with very good associates, and is easily reduced; but the situation of the mines is bad. In the former, the ore is in large veins, with bad associates, and is more difficult of separation and reduction; but the mines are admirably situated, whether we regard the removal of the ore, or the facility of transporting the produce of it."—p. 51.

The associates here referred to, are blende and copper and iron pyrites, the first of which constitutes a large part of the vein. The mines of Rossie have not been worked since 1839.

Manganese ores.—Manganese is found most abundantly in the counties of Columbia and Dutchess, where it occurs in marshes and is mostly the bog variety. According to Mather, fifty thousand tons of ore could be obtained at these deposits with little

expense. Mr. M. suggests that this bog manganese is derived from the decomposition of brown spar. The deposits occupy a narrow range in the vicinity of a slate rock containing this mineral; and the spar may often be seen under its original form, consisting of manganese, the result of decomposition.

Hydraulic Limestones.—Passing by the chapters on Gypsum and Marble, we cite a few of Dr. Beck's remarks on hydraulic limestone. These limestones abound in the state, and, as stated by Mr. Mather in 1839, six hundred thousand barrels of cement were manufactured in Ulster County alone, and much of it shipped for foreign ports. The vicinity of Chittenango affords about one hundred thousand bushels annually.

The hydraulic character of these limestones in general depends on the silica, or silica and alumina or magnesia, which are intimately mingled with the carbonate of lime in the constitution of the rock. The earths are in a finely divided state, and as they are disseminated uniformly through the rock, the particles are in the best condition possible for an immediate combination with the lime, particle to particle, to produce the silicates upon which the strength of the cement depends. A common fault with ordinary mortar is that the sand is coarse, in consequence of which only the exterior of the grain enters into these combinations. But in the hydraulic cement the silica and lime are not only in a finely divided state, but are also intimately mingled, in a manner which art could not imitate without much labor and expense. The hydraulic character has been attributed also to oxyd of iron, manganese, and even soda. Some or all of these substances may improve its quality, but silica appears to be the most essential ingredient. Dr. Beck says:

"It appears from the experiments of Berthier and Vicat, the highest authorities upon this subject, that no mixture, of which silica does not form a part, acquires hydraulic properties; that limes containing only silica or alumina, or better those containing silica and magnesia, acquire a much greater degree of hardness than the silicates of pure lime; and that the oxides of iron and manganese contribute nothing to the hardening of these bodies." —p. 76.

Prof. Beck gives the following as the composition of the hydraulic limestone of Rondout, Ulster County, before and after calcination, (p. 78,)

	Before calcination.	After calcination.
Carbonic acid,	34.20	5.00
Lime,	25.50	37.60
Magnesia,	12.35	16.65
Silica	15.37	22.75
Alumina,	9.13	13.40
Peroxyd of iron,	2.25	3.30
Loss,	1.20	1.30

and remarks that the calcined product approaches in composition a double silicate and aluminate of lime and magnesia. The following are his analyses of other hydraulic limestones.

	Scholharie.	Chittenango.	Chittenango.	Manlius.	Grand I.	W'insville.
Carbonic acid,	40.34	38 65	40.95	39.80	41.01	37.66
Lime,	31.75	27.35	29.00	25.24	28.79	26.11
Magnesia,	14.91	16.70	17.30	18.80	17.70	16 48
Silica, Alumina,	11.50	8.95 / 4.90	11.00	13.50	12 25	18 45
Peroxyd of iron,	1.50	1.75	1.50	1.25	——	——
Loss,	——	1.70	0.65	1.41	0.25	1.30

Prof. B. remarks, that "the process of burning or calcining the limestone requires great care. A limestone, very proper in other respects, gives, when the heat is urged too high, what is called a *dead lime*, in consequence of the partial fusion of the mass; whereas, when the calcination is effected at too low a temperature, the resulting lime is meagre, and not hydraulic.

"Hydraulic lime should be used as soon as possible after calcination; and when kept for any time, it should be carefully protected from the action of the air. It has been ascertained that the hydraulic property of limes is much weakened by their being exposed to the air; and consequently, all other things being equal, recently prepared hydraulic lime is to be preferred for important structures, to that which has been for some time manufactured.

"It is generally agreed that the rapidity with which hydraulic mortar hardens, and the ultimate degree of hardness which it acquires, depend greatly upon the proper proportions of lime and sand, their intimate incorporation, and the amount of water employed in their mixture. All these are points which must be settled by previous experiments."—p. 77.

In Ulster County, where the hydraulic limestone abounds and is largely worked, the following is the mode of preparation.

"The limestone is first reduced to small fragments, which are then thrown into a kiln with layers of the screenings of anthracite intermixed. At an interval of twelve hours, the lower layers of the kiln are removed, and fresh portions of the limestone thrown into the upper part. These operations are so managed that each layer is subjected to heat for about three days. The lime thus calcined is of a light drab color; and when reduced to powder and mixed with about one third its bulk of sand and made into a paste with water, soon becomes hard. The grinding is performed in a mill, and the powdered cement is put up in barrels which are lined with paper to prevent as much as possible the access of air."—p. 77.

In the following chapters, Dr. Beck treats of the marl deposits, and the brine and other mineral springs in the state, which we need not notice here, as the principal facts have already been stated in this Journal. With regard to the origin of the salt in the Brine Springs, Dr. B. argues that there are beds of rock-salt below, from which it is dissolved, and opposes the view that salt is disseminated in particles through the rock. Both suppositions may be true; like lime, salt may be disseminated in beds or in grains, and in either case might give origin to brine springs. Both sources probably exist in the state of New York. Leaving these discussions without further remark, we pass on to

Part II, entitled Descriptive Mineralogy, which includes complete descriptions of all the various minerals of the state. The specific characters of each species are given as in common mineralogical treatises. This is more than should have been expected in a state report; but it renders the work more complete in itself and more convenient for those who have not other general works on mineralogy at hand. A large number of crystalline forms is given. But a small proportion of the figures, however, are new, and much yet remains to be done in studying out the more complex crystallizations of some of the New York minerals. Very many of the forms, although before known, are for the first time identified in any work, with the different localities in the state, and much useful information is thus conveyed. The localities are described with great fidelity, and whatever pertains to the habits of the species, their accidental variations and mineral associates. In addition a number of new analyses are given.

The number of species detected in the state is one hundred and fifty. In the following remarks it will be most convenient to follow the course of the work, and extract such facts under the several species as may be new.

One new species, proposed by Prof. Beck, we may first notice. It is named *Hudsonite.* It belongs to the augite family, and as Rammelsberg remarks of the closely allied mineral, Polylite, (Handwörterbuch, II, 69,) it is near the variety Hedenbergite. In cleavage and angles it resembles a massive black augite. H.= 4·5—5. G.=3·5. Lustre vitreous, resinous, opaque. Before the blowpipe it fuses with effervescence to a black bead, attractable by the magnet. Composition according to Prof. Beck, silica 37·90, oxyd of iron 36·80, alumina 12·70, lime 11·40, magnesia 1·92. Except in the absence of oxyd of manganese, it differs but little from Polylite. It was found by Dr. Horton in a vein of quartz in the town of Cornwall, Orange Co. The Polylite of Thomson is stated to have come from Hoboken; but Prof. Beck remarks that this must be an error, as no bed of magnetic iron ore, in which it was said to occur, is known to exist there.

The *Eupyrchroite* of Prof. Emmons, is shown by Prof. Beck, to be a mammillated phosphate of iron, and the *Chiltonite* of the same author, to be Prehnite. The Rensselaerite is shown to be a steatitic pyroxene, quite similar to the steatitic pyroxenes of Sahla, analyzed by Rose. Its crystallizations, when distinct, have the form and angles of pyroxene. On analysis, Prof. B. found a specimen from Canton, St. Lawrence Co., to consist of silica 59·75, magnesia 32·90, lime 1·00, peroxyd of iron 3·40, water 2·85. It fuses with difficulty before the blowpipe to a white enamel. It occurs of white, gray and green colors, often dark or even black. The light colored varieties are sometimes translucent. H.=3—4. G.=2·874. It is easily worked in a lathe, admits of a neat polish, and is wrought quite extensively into inkstands, &c.

We proceed with the species in the order of the work.

Heavy Spar.—At Schoharie, heavy spar is mechanically mixed with strontianite and carbonate of lime. The calstronbaryte of Prof. Shepard is one of these mechanical compounds. (p. 207.) At Carlisle also a fibrous heavy spar contains largely of carbonate of lime, and "in some places seems to pass into fibrous carbonate of lime, by almost insensible gradations." The fibres are from a

quarter to an inch and a half in length and have a lustre between resinous and pearly.

Strontianite.—"The Emmonsite of Dr. Thomson is certainly nothing more than a mechanical mixture of carbonate of strontian and carbonate of lime."—p. 213.

Calc Spar.—The Rossie lead mines and other places in the vicinity have afforded splendid crystallizations of calc spar. "Crystals have been obtained twelve inches in diameter, with all the sides perfect," p. 224; one in the cabinet of B. Silliman, Jun. weighs one hundred and sixty five pounds, and although a cleavage crystal in part is finely modified on several of its angles and edges. Prof. Beck has given a number of the simpler forms from this region. The accompanying figure, (fig. 1,) by the writer, represents one of the more complex, not of unfrequent occurrence. The crystals are very commonly rhombohedrons, with a few planes on the edges and angles. The scalene dodocahedron, simple or modified, is another frequent form. They are often compounded parallel with the terminal plane, and also with a prismatic plane on the lateral angles, and some crystals consist of six individuals thus combined. Crystals are occasionally observed in which the terminal plane of the modified rhombohedron, has been covered

Fig. 1.

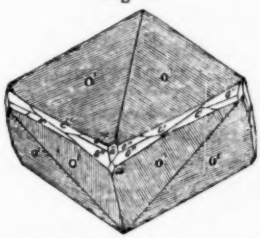
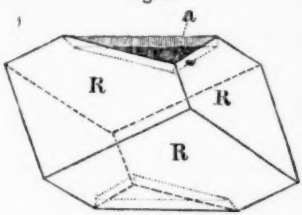


Fig. 2.



with a layer of pyrites, and afterwards built upon by subsequent crystallization, until the rhombohedron was completed and the plane wholly obliterated. The writer is indebted to Prof. Emmons for the examination of a specimen of this kind. Prismatic specimens are not uncommon in which the terminal pyramid (the primary faces) has been similarly incrusted with pyrites and then covered again with crystallizing lime. Another singular effect of intermitted crystallization is represented in the annexed figure, (fig. 2.) In these crystals, the plane a is bordered by an elevated rim, a twelfth of an inch or so high. The crystal after an inter-

val in which the process of crystallization was suspended, commenced again to enlarge—owing perhaps to a new supply of the calcareous solution:—but at this time the crystal is so changed in condition, or in its attracting influences, that the laminæ added to the rhombohedral faces, were no longer modified as before, and consequently, instead of enlarging the face *a*, they extend above it, and form a border around it. The calc spar of this region is often transparent and presents yellow, rose and amethystine tints in addition to the more common shades.

Apatite.—The apatites of St. Lawrence Co., are remarkable for their size. One from Hammond measured nearly a foot in length and weighed eighteen pounds. The crystals are usually the six-sided prism with simple pyramidal terminations. Very often the faces and edges are rounded, and some crystals are curved or bent. Deep and pale green and blue are the common colors.

Magnesian Carbonate of Lime.—Prof. Beck found the *Pearl spar* of Lockport, to consist of carbonate of lime 59·00, carbonate of magnesia 39·50, carbonate of iron 1·50. The variety called *Gurhofite* from Phillipstown—a white compact rock, having a semi-opaline appearance and a fracture like porcelain, consists of carbonate of lime 66·75, carbonate of magnesia 26·50, silica 6·75. An allied variety from the Quarantine, Richmond Co., gave carbonate of lime 52·75, carbonate of magnesia 42·25, insoluble matter chiefly silica 5·00, with traces of oxyd of iron. Sp. gr.=2·712. It is a tough rock and is difficult of solution, except when finely pulverized.

Magnesite.—Under this name Prof. B. includes the marmolite of Nuttall, which is properly a foliated serpentine, as it is identical with it in composition; also kerolite and meerschaum. A mineral from Westchester sometimes labelled kerolite, presenting thin brittle plates of a white or green color, subtranslucent and somewhat resinous in lustre, afforded him, silica 40·50, magnesia 38·00, water 21·09, with a trace of iron. This composition agrees nearly with that of serpentine, of which this mineral appears to be a variety. Another specimen from the Quarantine, Richmond Co., where it occurs in thin seams in serpentine, gave nearly the same composition. A variety from Stony Point, Rockland Co., afforded him, silica 37.40, magnesia 32.56, oxyd of iron 10.05, water 14.60, alumina 5·35, with a trace of oxyd of manganese. It occurs with other magnesian minerals in trap, forming narrow

veins of dull white grayish and greenish colors. It is infusible except on the thinnest edges, which become rounded and the color of the mass lighter. Prof. B. suggests the name Rocklandite for this mineral, if received as a new species.

Hornblende, Pyroxene.—A large number of interesting localities of these species are given by Prof. Beck. We refer to his work for them, and notice here only one or two hornblende pseudomorphs. One from Warwick, having the form and cleavage of hornblende, resembles steatite in *feel* and *hardness.* The crystals are six-sided prisms with dihedral summits, and are sometimes bent and distorted. Prof. Beck found them to consist of silica 35·00, alumina 32.33, lime 10.80, magnesia 20.70. They occur in limestone with mica, fluor and chondrodite. These crystals are "probably hornblende altered by an intrusion of alumina and a removal of part of the silica. The contorted and somewhat fused appearance of many of the crystals clearly point to heat as the agent by which these changes have been produced." Prof. B. asks, "may not the chondrodite have been formed by the combination of the silica which these crystals have lost, and the fluor from the decomposition of the mica?" mica having also contributed, as he before suggested, to furnish the additional alumina.

Another pseudomorph in long rhombic prisms with the angles of hornblende, and presenting a grayish green color, with the softness of talc, afforded Prof. B. silica 34·66, alumina 25·33, lime 5·09, magnesia 25·22, water 9·09.

Hypersthene.—Prof. Beck finds on analysis, that the hypersthene of northern New York, differs little in composition from common pyroxene. He obtained for a specimen from near Ticonderoga, silica 45·45, lime 24·33, magnesia 18·00, oxyd of iron 11.49.

Idocrase.—The *xanthite* of Warwick, has the crystalline form and composition of idocrase, and there is no doubt of the identity.

Feldspar and *scapolite* occur under a great variety of forms and in crystals of unusual dimensions; but we pass on, referring for an account of them to Prof. Beck's work.

Stellite.—The mineral from Bergen Hill, supposed to be the same with Thomson's stellite, consists according to Prof. B. of silica 54·60, lime 33·65, magnesia 6·80, oxyd of iron and a little alumina 0·50, water and carbonic acid 3·20.*

* See Dr. Beck's article on the minerals of Bergen Hill, in this Journal, Vol. XLIV, p. 54.

Clintonite.—This mineral is the Seybertite of Clemson and Holmesite of Thomson. It was named Clintonite about fifteen years since by its discoverers, Messrs. Finch, Mather and Horton, in honor of De Witt Clinton.

Zircon.—Highly interesting crystals occur at Hammond, St. Lawrence Co., and Johnsburg, Warren Co. Some of the prisms are an inch and a half long, and half an inch through. They sometimes contain a large proportion of carbonate of lime, and occasionally the crystals have a tesselated structure, somewhat resembling chiastolite, the faces being white except the angles, which are a rich brown. The annexed figure, (fig. 3,) represents a crystal of this kind; the crystals are white excepting the part about the angles within the dotted lines. The plane *o'* is absent from part of the angles, owing to the extension of the other planes. Some crystals have a nucleus of carbonate of lime. The longer prismatic crystals are often bent or broken in the rock.

Fig. 3.

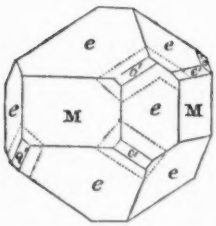


Fig. 4.

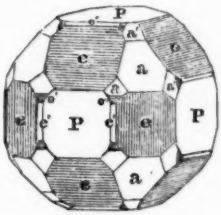
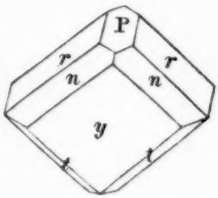


Fig. 5.



Iron Pyrites.—Interesting forms of pyrites occur at Rossie, some of which are figured by Prof. Beck. Figure 4, by the writer, represents a brilliant crystal from that region, an inch in diameter, in the possession of Prof. Emmons.

Sphene.—This mineral is abundant in the counties of Orange, St. Lawrence, Jefferson and Essex. In Warwick the crystals are sometimes nearly two inches in breadth. A variety from Phillipstown in Putnam Co., Grenville in Upper Canada, Natural Bridge, Lewis Co., and elsewhere, has been described by Prof. Shepard as a new species, on crystallographic considerations, by the name of *Lederite*, under which name it is referred to by Beck. The accompanying figure, (fig. 5,) represents the crystal figured by Prof. Shepard, reversed in position; by comparing it with figure 229, (a crystal of sphene,) in the last edition of Mohs, it will be found to be identical, except that the latter has

a few additional planes. Moreover there is but little difference in the angles as given by Prof. Shepard, and none as far as is known, in composition.

Allanite.—The allanite of Monroe, Orange Co., where it occurs massive, of a brownish black color, resinous and submetallic lustre, gave Prof. B. on analysis, protoxyd of cerium 24·90, silica 30·50, alumina 11·25, protoxyd of iron 22.27, lime 9·87.

J. D. D.

ART. IV.—*A Catalogue of the Reptiles of Connecticut, arranged according to their natural families;* prepared for the Yale Natural History Society, by Rev. JAMES H. LINSLEY, A. M.

TO THE SECRETARY OF THE YALE NATURAL HISTORY SOCIETY:

Dear Sir—I herewith transmit to the Society a list of the *reptiles* of Connecticut, as far as ascertained, and as my efforts to make it complete have been extensively exerted, it is believed very few, if any more species will soon be obtained in the State.

I would take this opportunity to tender my thanks to those gentlemen who have from various towns kindly favored me with specimens, and to those who have informed me of localities of some rare species, to which reference is occasionally made in the notes of this catalogue. My thanks are also especially due to Professor Silliman and Son, for the free access at all times to their valuable libraries, and for the loan of such books as I could not otherwise obtain, not only on this, but every branch of natural science, to which my attention has been directed.

The notes in the following list are somewhat extended, but it is hoped they will not be found altogether uninteresting.

It was my intention to have accompanied this with catalogues of the fishes and shells of Connecticut, both being nearly ready, but it is desirable to establish some undecided points with regard to a few species. My hope is to complete them both in the course of this year; and specimens and communications relating to the discovery of any new species in the zoology of Connecticut, will be acceptable.

Generally in this list, as well as in those which have preceded it, the old names have been preferred, where as it seemed to me no permanent good would be obtained, by the use of modern synonyms. I hope however the article will be not the less in-

teresting on that account. It is mentioned here merely by way of explanation.

Class III. Reptiles.

Order Testudinata.

Family *Chelonidæ*.

*1. Chelonia mydas, Linn., Green Tortoise, Stratford.

*2. Chelonia? ——— ? Long Island Sound, New London.

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*1. An individual of this species was taken a few years since by a shad seine, seven miles up the Housatonic; length about 2 feet, and 1½ feet wide—was kept several weeks confined in a pen made in the river, at the lower wharf in this village, about three miles from Stratford Point. It was fed on vegetables, such as cabbages and various esculents from the garden, with an idea of making him fat for the table, but he refused to eat, and finally died, though confined in salt water. From the film over the eyes, he was evidently sickly when taken, as this is always a *symptom of disease* in the whole family.

Another individual of this marine tortoise was taken by a harpoon a few years since at the mouth of the Housatonic, and the upper shell somewhat injured was preserved and sent to me by Mr. Sidney Beardsley of this town. Length of shell 17 inches, width 15 inches. It perfectly agrees with a figure of the *C. caretta* in "*Catesby's History of Carolina, Florida, and the Bahama Islands*," and is very unlike Dr. Holbrook's figures of either species; but not satisfied with a work of 1772, I forwarded it to Dr. Storer for the Boston Society of Natural History, and "after comparing it with several specimens of different ages and different localities, I am satisfied," (writes Dr. S.) "it must be the *mydas*." This species is very rare, but occasionally an individual is taken at Stonington and New London, as well as Stratford.

*2. Mr. Wm. G. Buell of Chatham in this state, informs me that "about ten years since there was a tortoise taken in the Sound near New London, by two men in a fishing smack. They first struck it with a harpoon in the fore part of the shell, and though it made a gash 12 inches in length, it was so hard it turned off, and they feared they had lost him; but they had another good throw of the harpoon into the neck as he rose at the bow of the smack, and secured him. It was afterwards exhibited in an ox cart, and thus conveyed about the country for a show. Mr. B. thinks it would weigh from 500 to 700 pounds. Shell 4 to 5 feet long, and flippers 3 to 4 feet." I imagined it might have been the Leather Tortoise, No. 3, and showed him the figure of it, but he was "sure it was not that shape, but nearly round like our common speckled turtles." It had a rudder for a tail about a foot long, shaped like a scow rudder, (i. e.) wide and flat perpendicularly. His mouth was filled with little pipes like porcupine quills, and he evidently lived by suction through these quills. He thinks it was not the shell tortoise, *Chelonia imbricata*, Holbrook. I addressed a line of inquiry on the subject to a young friend in Stonington, (Mr. Trumbull,) and in reply he writes: "Of the monstrous turtle taken in Long Island Sound about ten years since, I have a faint recollection, as exhibited at a military review, at which I chanced to be present, but did not see it, nor can I say any thing of it, or of its capture, with certainty." This is all I can learn respecting it hitherto. It is inserted here with earnest request that if it meets the eye of any person who can give a just account of it, and of its specific name, &c. he will please do so for the benefit of science.

*3. Sphargis coriacea, Mer., Leather Tortoise, Long Island Sound.

*4. Testudo palustris, Linn., Terrapin, Housatonic River.

*5. Emys terrapin, Schœpff., Smooth Terrapin, Stonington.

*6. Emys picta, Schneider, Painted Tortoise, common.

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*3. Cuvier, (Vol. II, p. 10, Am. ed.) says, "Merrem has recently distinguished by the name of *sphargis* those Cheloniæ whose shell is destitute of plates, and merely covered with a sort of leather, such as the *Testudo coriacea* of Linnæus." Dr. Dekay, in his report on the zoology of New York, page 5th, says: "A fourth specimen [found on our coast] was taken Sept. 7, 1826, in Long Island Sound." Dr. Storer, page 217 of his Report to the Legislature of Massachusetts "on the fishes and reptiles of that State," describes a specimen taken in Massachusetts Bay in 1824, of which he gives a good figure by Dr. Wyman. Length, 85 inches, widest part 14 inches. His leathery covering was 57 inches in length. These proportions are mentioned here as very extraordinary for any species of tortoise—over 7 feet long, and little more than a foot wide! Our Connecticut specimen is believed to have been of no less dimensions.

*4. This is the *Testudo concentricus* of Shaw. I had a specimen of the upper shell from Cheshire in this State, which measured 8 inches long, and 6 wide, which I forwarded to Dr. Storer, Boston. I have had also two specimens of the living animal from the Housatonic this season, of the same dimensions. Dr. Shaw, page 43, Vol. III. says, "they are from 4 to 6 inches long. But Dr. Brown describes them as 8 or 9 inches long in Jamaica—are sold in Philadelphia market as terrapins." They are in my estimation superior to any of the genus for the table. The fact that they are common in Cheshire, about 14 miles not only from salt but even *brackish* water, evinces that Dr. Dekay is mistaken in his assertion on page 11, of his Report, viz. "It is well distinguished as the *salt-water terrapin*, for it is found *exclusively* in salt or brackish streams near the sea-shore." He also adds, "geographical limits from Mexico to New York, and northern shores of Long Island." This and the following species were for a long time considered the same. Major Le Conte, however, who is considered good authority in herpetology, saw females of both of the same size, and considered them different. (See Dr. Dekay's Report, Part III, p. 11.)

*5. Dr. Holbrook says this species is found as far east as Rhode Island. I have obtained the shell of a young specimen from Mr. J. H. Trumbull, taken at Stonington, which exhibits the principal difference between this and the preceding, as noted by Dr. Dekay; and it agrees much better with Dr. Holbrook's figure, than with my specimens of the preceding species. It has but one half as many concentric lines on the lateral plates; and the last dorsal plate is much larger, and unlike in shape to the same plate in the preceding species. How much is to be ascribed to the difference arising from age, I believe is not stated, though I doubt not I have the shells of what are considered the two species, and both found living in Connecticut waters.

*6. This species is found in most of our brooks and ponds of fresh-water. I picked up a specimen in this town in 1842, which was crossing the road, and found it marked "1821;" being 21 years since its mark was received, and its general appearance evinced the probability it was marked at the time named. I preserved it for my cabinet, and the shell measures 5 inches in length and 3½ in width, about a medium size.

*7. Emys guttata, Schneider, Speckled Tortoise, common.

*8. Emys insculpta, Le Conte, Wood Tortoise, Stratford and Hartford.

*9. Sternothærus odoratus, Bosc., Musk Tortoise, Stratford, East Hartford, and Stonington.

*10. Chelonura serpentina, Linn., Snapping Tortoise, common.

*11. Cistuda clausa, Schœpff., Lock Tortoise and Box Tortoise, common.

*12. Cistuda Blandingii, Holbrook, Blanding's Tortoise, Darien.

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*7. Both this and the preceding species are nearly round, until about half grown, and are so unlike in shape to the adults, that were it not for the external markings upon the shells, they might easily be taken for other species.

*8. The first specimen of this species I received from Cheshire by the hand of Benjamin Brooks, Esq. of Bridgeport. Length of shell 6½ inches, width 5 inches. Since then, I have taken it in the Housatonic near Derby, and find it not very rare. Mr. S. Crofut of Derby assured me that he once laid one of these tortoises on its back upon a rock, and laid a stone on it to retain it in that posture, and three weeks after he found it in that situation as he left it, but apparently as lively and well as ever. He then turned it over and put on the stone again; and after a great length of time had elapsed, having forgotten it, he found it as well as ever, and then released it. It hobbled off quite satisfied with the opportunity so to do. Though this savors too strongly of cruelty, it evinces a wonderful capacity of the animal to sustain life under these very trying circumstances.

*9. I took one of this species in the Housatonic, Sept. 20, 1841, and another in Trumbull, July 25, 1843,—the only specimens I recollect to have seen, and it may therefore be considered rare. It is the smallest of all the family inhabiting New England, at least as yet discovered.

*10. This species is quite common throughout the state, and is much used as an article of food, and is at times found very large: one taken at Stonington in June last, measured 37½ inches; shell 16½ inches long and 13 inches wide, and weighed 23½ pounds. Another has since been taken there which weighed 28 pounds, as Mr. J. H. Trumbull informs me.

*11. This is the most beautiful of all the race of tortoises in our country, and the only one with which I am acquainted that is found habitually on land. They live to a great age, if we may trust the markings and dates, often found on their under plates, of which in most instances we have no reason to doubt. I found one some time since, that I had marked when a small lad,—the number of years I do not now recollect, as I then hoped I might be favored to find him again in years subsequent. The covering to this shell is such as to render marking easier and more distinct than that of any other species, and evidently causes the animal no suffering more than even paring the nails. A specimen before me measures 6 inches long, and about 4½ wide—a medium size.

*12. This tortoise, called by Dr. Dekay *Blanding's Box Tortoise*, is found both east and west of us, (Massachusetts and New York,) it is therefore doubtless an inhabitant of Connecticut. In August 2, 1843, I saw mounted on a stick projecting from a small pond in Darien in this state, a tortoise I took to be this; I came so near as to be on the point of laying my hand on him, when he slid off

Order II. SAURIA.

Family *Scincidæ*.

*13. Scincus fasciatus, Linn., Blue-tailed Skink, Salisbury and Trumbull.

Family *Agamidæ*.

*14. Tropidolepis undulatus, Bosc., Brown Swift, Pine woods.

Order III. OPHIDIA.

Family *Colubridæ*.

15. Coluber sirtalis, Linn., Striped Snake, common.

*16. Coluber saurita, Linn., Ribbon Snake, Stratford and Stonington.

*17. Coluber ordinatus, Linn., Little Brown Snake, Stratford, Stonington and Bridgeport.

*18. Coluber vernalis, Dekay, Green Snake, Stratford, Northford and Canaan.

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and escaped to my great regret. I believed it certainly this, or the preceding species, to which it is nearly allied; and as I have never seen the latter in water, it was probably the true *Blanding's Tortoise*. It was to me a little remarkable, as being the same place where I obtained the *Sorex parvus* mentioned in this Journal, Vol. XXXIX, p. 338. I then supposed the place to belong to the town of Stamford, but have since ascertained it belongs to Darien.

*13. Frederic Plumb, Esq. of Salisbury, Litchfield County, a gentleman of much observation, assures me he has often seen this beautiful animal in that town; and Mr. Benjamin Beers of Stratford, lately saw several in Trumbull, while he was pulling down an old building.

*14. The *brown swift* has, according to Dr. Dekay's recent "Report on the Zoology of New York," been found in both Dutchess and Putnam counties; and as these join almost the whole western line of Connecticut, it scarcely admits a question that the animal has just claim to insertion here; especially too as its habitat is from the Gulf of Mexico to the 43d degree of north latitude. I have no specimen of this family belonging to North America, except *Phrynosoma cornuta*, of Holbrook, commonly named "*the horned toad with a tail;*" received from Texas, where it is not uncommon, but is here considered a great curiosity.

*16. This species of striped snake is much less common than the preceding; is more slender and more resembles a whip-lash. The distinction between the two, is not generally known, except by naturalists. Both harmless, and feed on toads and frogs.

*17. The grass snake or little brown snake is not uncommon in Stonington. Mr. Trumbull informs me that he has taken three individuals this season. The Hon. Daniel Plant of Stratford, believes he killed a specimen of this snake in his garden, March 22, 1842. I have two fine specimens taken this season in Bridgeport by Mr. E. Thompson.

*18. I received a specimen of the *green snake* August 13th, 1843, from Mr. Charles Wells of this town, which he had recently killed here. Length 11 in-

*19. Coluber punctatus, Linn., Ringed Snake, Northford and Hartford.

*20. Coluber constrictor, Linn., Black Snake, common.

*21. Coluber Alleghaniensis, Holbrook, White-throat Racer, Northford.

*22. Coluber sipedon, Linn., Black Water Snake, common.

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ches. I once saw a much longer individual of this species in Northford. Mr. William G. Buell of Chatham, informs me he has lately seen one in that town, and on visiting Litchfield County recently, I find it is not uncommon in the northern parts of the state.

*19. I have taken many individuals of the ringed snake at Northford, New Haven County. Mr. Wm. O. Ayres, an enterprising naturalist of East Hartford, informs me, that he has seen one in that town the present season. Since writing the above, I have seen a fine specimen at Darien, in this county, and heard of several others. They are found under stones and more commonly under large clods in new ploughed fields, and sometimes under the bark of decayed trees. Length about 12 inches. Color bluish brown, with a white band around the neck. These remarks are made here in order that it may be easily distinguished from the *racer*, which is much longer. A gentleman in North Canaan lately informed me that one of the large black ringed snakes, mentioned below, chased him I think about sixty rods, and he then turned back upon him and killed him.

*20. The common black snake is quite destructive to young birds. I have seen him entwined around the bushes of the *Cephalanthus occidentalis*, (button bush,) on which the red-winged blackbirds usually build their nests; and thus he gorged a whole nest full of young birds, nearly ready to fly; while a large flock of the old birds were pouncing down towards him in agonies at his cruel depredations.

*21. I have seen and killed many of the long *white-throated racers* in Northford from four to six feet in length. It is the most fleet and sprightly of the whole family in our state. It usually frequents hills and mountainous situations. I have seen one when greatly irritated bite his own back. But it is not poisonous. I have seen the striped snake (No. 15) do the same and with most manifest malignity. They *strike* with the upper jaw, rather than bite. As it is so long since I have seen the *white-throated racer*, I cannot be positive it is this species. The *carinate scales* would at once determine the point.

*22. The black water snake often manifests a disposition to bite and occasionally does so. One instance has been known to me in which the body of the snake was severed in two by a scythe; the head portion was about a foot in length, and it then bit the mower in the foot, (on the instep;) it swelled badly, was troublesome for a length of time, though I believe no remedies were used to alleviate it, as it was correctly believed not to be dangerous. They occasionally climb trees to a considerable height, say ten or twelve feet, and crawl out upon a limb and hang over water, for what purpose I have not ascertained, though I saw one in this county either leap or fall from an extended limb of a large tree into the water, on driving my horse into the water to drink. He appeared quite agitated, and escaped in the water, notwithstanding all my efforts to take him. I took one of these snakes in Stratford recently, endeavoring to swallow the *Rana halecina*. He had seized the frog at right angles between the fore and hind leg; the frog appeared perfectly quiet, and a blow from a stick, on the snake, released him.

*23. Coluber getulus, Linn., Chain Snake, Milford.

*24. Coluber leberis, Kalm, Yellow-bellied Snake, Orange and Canaan.

*25. Coluber eximius, Dekay, Milk Snake, Huntington and East Hartford.

*26. Coluber amœnus, Say, Red Snake, Preston.

*27. Coluber Dekayi, Holbrook, Dekay's Brown Snake, Stratford and Canaan.

*28. Coluber occipito-maculatus, Storer, Stratford.

*29. Heterodon platyrhinos, Holbrook, Flat-headed Adder, Stratford.

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*23. I am informed by Mr. Nettleton of Orange, that he has seen the *chain snake* in Milford. As he is an observing man, possessed of good judgment and quite a taste for natural history, I have inserted it here. I am also induced so to do, from the fact that this as well as the following species are both found near New York and on Long Island. (See Dr. Dekay's Report on New York Fauna, Part III, page 37, with figures.)

*24. Mr. Nettleton assures me that he has killed the *yellow-bellied snake* in the town of Orange. He so decided on seeing Dr. Dekay's figure of this species, to which I had called his attention. Mr. Lawrence also of Canaan, Litchfield County, an observing gentleman, is sure he has killed this snake in that town.

*25. I killed one of this species in Huntington about a year since, two feet two inches in length. It is doubtless found in all our counties. It sometimes in this county has been known to enter a grist-mill and remain a length of time for the apparent purpose of feeding on the mice which were there attainable. It is probable this is one principal object of his frequenting dwelling houses, and not always for the purpose of obtaining milk, as is generally supposed.

*26. The little red snake has been killed this season in the town of Preston by Mr. J. H. Trumbull. It is by no means common, although found in other sections of this state. His specimen was eight inches in length.

*27. The little brown snake is supposed by description to have been killed by Col. Edwards Johnson, at his residence in this town, in the summer of 1841, and in August, 1843, was killed by Mr. Munson in Canaan. It has been found in Massachusetts, Long Island and Michigan.

*28. I have seen several of the spotted neck snake here in autumn, usually nine to ten inches long, turned out of ground where they had evidently intended to pass the winter.

*29. This adder is not very uncommon. I have killed many of them in Northford and other parts of the state. Mr. Wm. O. Ayres has killed one this season in East Hartford. One was killed here last season while floating down the Housatonic, probably in the water by accident, as they do not frequent the water. The hiss of this snake is almost equally loud and certainly more threatening than that of a goose. Mr. Trumbull mentions a specimen taken near Stonington about four feet in length, and says it is there called a *red snake* and is often confounded with the chunk-head, and supposed by some persons to be a new species. This length indeed is very uncommon.

Family *Crotalidæ.*

***30. Trigonocephalus contortrix, Linn., Copper-head, Stratford, Hartford and Litchfield.**

***31. Crotalus durissus, Linn., Banded Rattle Snake, Weston.**

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*30. The *copper-head*, called also *chunk-head*, *red snake*, &c. is occasionally found in most parts of Connecticut. One was killed in Stratford this season, two in Trumbull, one in Litchfield, &c. I saw one some years since in Northford, which was found stretched at full length under a fruit tree, where a child had been passing around for fruit. I should judge he was at least two inches in diameter. Mr. Benjamin Beers of Stratford, who informed me of the two individuals of this species killed this season in Trumbull, says his father was bitten by one, and though very dangerously ill, was cured by drinking horehound (*Marrubium vulgare*) and applying it to the wound. The father said that every thing he put in his mouth after the wound of the snake tasted sweet. Mr. B. has often made this species of snake bite a white rag tied at the end of a pole or stick, and says the rag is instantly colored green, extending to the size of a cent. While harmless snakes are always still at night, this snake, as well as the rattlesnake, is found as active as at any time in the day.

*31. The rattlesnake is not common in Connecticut, though found perhaps in more than half the towns in the state. There is a large den of them in Weston. I have seen a few specimens in Litchfield County, uncommonly large. We have but one species and that much less common than formerly. But in Georgia and Florida there are four or five species of this dreaded animal. The *C. adamantius* of Holbrook is found from six to eight feet in length. These are often killed by common deer, which leap on them with all four feet touching each other and off so quick that the snake has no power to bite, and this the deer repeats until he completely despatches him. Mr. George Walter assures me that he witnessed this fact this season in Missouri, while secreted in the bushes near the operation.

Capt. Richard F. Floyd of Georgia, quite distinguished as a naturalist and a great observer of this genus of animals, has tried many experiments upon them, some of which are very interesting. He had several individuals of living rattlesnakes, one of which was seven feet eight inches in length, (of the *adamantius* species probably.) He wrote to me that it was confined in a barrel seven weeks, during which time it neither ate or drank. During its confinement the barrel was placed in the farthest corner of a large room, and although (he says) "I made very frequent attempts to approach the barrel stealthily, both by day and by night, I was unable to get nearer than the entrance of the door, without its rattling. I tried it in stocking feet in the most silent and cautious manner, but always with the same results—its rattles always proclaiming its knowledge of my approach, and increasing from at first a slow measured shaking to their full play, as I came nearer its prison. Rattlesnakes seem however to vary much in their dispositions, and I have seen them in one or two instances, when at large, that could neither be provoked to rattle or coil, (their coiling and rattling being generally simultaneous,) but would use every means to escape." [I suppose this fact arises from a consciousness of deficiency in their poisonous secretions at the time.] "Among other experiments, we made one with a young alligator two and a half feet long. It was placed near the snake and made every effort to turn and escape, and evinced much alarm. Upon its being forced within striking distance, the snake bit it twice upon the head. In one minute after, the alligator appeared to

be in a stupor, much resembling their torpor during winter. It was then placed in water, and remained with the wounded part above the surface in one position for an hour, when it expired. On examination, one of the fangs was found broken off in the tough head of the alligator. Thus was a doubt cleared up respecting the effect of snake poison upon this amphibious animal, that they are not exempt from its deadly influence. I have seen many hounds bitten by the rattlesnake, and never knew but one to recover, and that was bitten in October, and was always puny and miserable afterwards. In one instance, a dog lived but two minutes after being struck, (and that was in July,) although I have known some to survive from one hour to one day. But the result depends much upon the season of the year, which seems to have a powerful influence in regulating the venom of all snakes.

"It has been a current opinion that the rattlesnake possesses the power of contraction to such a degree as to defy the strongest man to hold it in his grasp, or to keep his hands asunder. I was induced to try it with one seven feet long. Having secured its head to enable me to seize it, I grasped it with one hand tightly around the neck immediately below the head, and with the other far below the middle; its head was then released. Although its power did not bring my hands together, still by slow degrees, it crowded through my hands in spite of my utmost pressure, until its head had gained a distance that made it unsafe for me to hold on any longer. During the time I held it, I felt an indescribable faint sickness from its horrible smell, and the cold *creeping* sensation it produced upon my nerves. The rattlesnake no doubt [in reply to some queries I had written him, Capt. F. adds] has the faculty to throw off or suppress a disagreeable effluvium. Soon after I had cast away the snake I regained my usual feelings."

Again, after stating his disbelief in the power of this snake to *charm*, he adds: "That they do entice their prey within their reach by some indescribable attractive power is possible, but I have never witnessed it; I have often drawn near the rattlesnake and looked it steadily in the eye until the intensity of my gaze became confused and dim from the most natural cause, without having any strange effect produced upon me. From the great number I have seen from time to time in our forests under a variety of circumstances, I am induced to discredit the power or *inclination* of the rattlesnake to charm man or any animal which is too large to supply its appetite. Still I doubt not that they possess some undefinable alluring power as above remarked, in securing their food; for otherwise how could they so frequently overtake the timid and *fleet-footed rabbit*, the *agile squirrel*, or the *aerial mock-bird*, all favorite repasts with the rattlesnake, which is clumsy and sluggish in its travelling gait, but quick as thought in its defense. I will here add in conclusion, a circumstance which occurred about ten days since, and was related to me by Mr. H——— of Cumberland, a gentleman of veracity and observation in these subjects. I give his own relation: 'I had driven down to where the road passed a scrub, when immediately in front of the horses, I discovered a huge rattlesnake crossing the road. I dismounted and followed the snake into the bushes, whilst it appeared perfectly regardless of my presence. I wondered at its total disregard of me, and repeatedly touched it with a stick which I had broken for the purpose, but it did neither arrest its progress, or in any way excite its notice. This appeared truly strange in an animal usually so sensitive. Whilst I was endeavoring to get an opportunity to kill it, I discovered the object of pursuit in *a full grown rabbit* within fifteen feet, and immediately in front of the snake. The rabbit appeared to disregard *me*, but with its attention fastened upon the snake, made several springs in an oblique approximation to the snake's course, which also changed its route to that of its victim. These maneuvres occurred sev-

*32. ———? ———? Chatham.

eral times, the rabbit watching the approaching danger with a seeming drowsy stupidity, until it came within six feet, at which time I made a blow at the snake. It did not rattle until I had injured it severely by repeated blows. After killing it, I found that the rabbit remained in one position near by, until I aroused it by one or two light applications of the stick, when it sprang away in the utmost fright. I much regret that my haste deprived me of the *finale* of all this.'"

I had been informed that Capt. Floyd on casting away the snake was taken with violent vomiting which lasted for six hours, and that every thing appeared green to his sight. I therefore on the receipt of the letter containing the above extracts, wrote him again to ascertain the truth, and he replied that my informant had blended two circumstances, one of which was a Mr. Fitchett having killed a large rattlesnake, to ascertain if it had any strong smell, brought his face in close contact with the belly of the snake, and almost instantly it occasioned violent vomiting, though the snake was dead. "But," Capt. F. adds, "the effect on myself was a faint sickening feeling, produced, I believe, from the idea of having a large and poisonous serpent in my hands, and from perceiving that it gradually and in spite of my utmost pressure increased the distance between its head and my hand, thereby gaining an advantage every instant which would soon enable it to bite my hand. This, and the necessity of casting it away clear, so as to prevent entanglement with any part of it, created a great excitement in me, (for from the moment I seized it, and felt its cold scaly creeping muscles working through my hands, I regretted that I had taken hold of it, and knew that the slightest loss of my presence of mind would endanger me,) and I believe created that sickening, nervous sensation which left me soon after I had thrown away the snake. Objects around did not 'appear green,' neither was 'vomiting occasioned.' Every thing wore the usual aspect—there was not a semblance of optical or other delusion—and the holding of a large live rattlesnake (together with its very disagreeable and suffocating smell) produced the most natural sensations possible upon the nervous system."

*32. Mr. Wm. G. Buell of Chatham, already mentioned, assures me that he has this season taken at Chatham a small snake, the length he imagines about nine or ten inches, with a horny tail, wholly unlike any other snake he has ever seen. He secured him alive, rolled him up in a newspaper and put him under a stone until his return from a short distance whither he was going, but on his return some boys had found him, and by accident or carelessness had lost him. Since that another specimen has been found of the same dimensions and similar tail, but was destroyed by the farmer who found and mashed him to fragments. The latter was said to be a pure or fine *flesh color;* his specimen was different in color but doubtless the same species. I showed Mr. Buell in my cabinet a fine specimen (as yet undescribed) of the *horn and hoop snake* taken in Alabama, (and presented me by Mr. Peabody of Bridgeport,) and Mr. Buell remarked that the *horn part of the tail* resembled that of my specimen, but that the snake in all other respects was wholly unlike. There is therefore unquestionably a new species and probably a new genus of snake in Connecticut, not yet ascertained. It is mentioned with a hope that some individual in that town or towns adjacent may succeed in finding and securing a specimen, and thus at least afford us some further intelligence on the subject, which will be thankfully received. It is believed this list embraces all the snakes we have in this state, two only of which are known to be dangerously poisonous or venomous.

Order IV. Batrachia.

Family *Ranidæ*.

*33. Rana pipiens, Linn., Bull Frog, ———, common.

34. Rana fontinalis, Le Conte, Yellow-throated Green Frog, common.

35. Rana halecina, Kalm, Leopard Frog, common.

36. Rana palustris, Le Conte, Pickerel Frog, common.

*37. Rana sylvatica, Le Conte, Wood Frog, common.

*38. Rana horiconensis, Holbrook, Northern Bull Frog, Canaan.

I have found the popular error quite prevalent, that the venomous snakes are viviparous, while the harmless ones are oviparous. This opinion is of course wholly unfounded, since it is well known that all reptilia are oviparous.

Allow me to add here, while on the subject of eggs, the singular fact that the egg of the *crocodile* of the Eastern continent has a thick heavy shell; while those of the *alligator*, and all those of other reptiles producing eggs in our country, have no shell. I have the egg of a crocodile from Burmah, about the size of that of our common goose, and the shell equally thick and hard.

*33. The bull frog devours its young in great numbers. One I took this season had his stomach greatly distended with the young of his own species, some as large as five or six inches in length, including the tail, and more than an inch in diameter, some of the largest young frogs with tail and legs attached that I ever beheld. They were not masticated, and very nearly perfect. I have since found another whose stomach contained many little shells, such as *Physa*, *Limnea* and *Cyclas*, with their animals partly digested. Frogs will survive a long time however without any apparent sustenance, except what they derive from the water in which they may be confined.

*37. The five preceding species are found plentifully in most of our fresh-water streams and ponds. They all occasionally pass over a great extent of land without water, as they choose to move either for change or amusement. I once knew a farmer, if the weather was hot and his oxen disposed to loll, as is not uncommon when much heated, who would send his plough-boy to the nearest brook to collect frogs, and on his return with them the farmer would open the mouth of an ox, and let one or two live frogs leap down, and it served always to cool the ox in a moment, so that he could immediately resume his ploughing without the danger of overheating the ox. I mention this fact here merely with the hope it may be useful to farmers as a means of preserving their oxen from a surfeit or overheating.

*38. This large frog, I learn from Mr. Munson in North Canaan, was some years since known to inhabit a small locality in that town near the residence of a Mr. Richards, and obtained the name of *Richards' frog*, being much larger and a different color from the bull frog. Back very dark, nearly black, sides green, and belly white. Mr. M. had often seen it, but for several years past it had been extinct. As this place (North Canaan) is not very distant from Lake George, where it was first obtained by Dr. Holbrook, there can be little doubt this frog once inhabited Connecticut. Dr. Dekay remarks that its note is very sonorous and on a lower key than the bull frog. Mr. Munson informed me that the voice is wholly dissimilar to that of our common bull frog. Dr. H. gave the specific name from the Indian name of Lake George—*Horicon*.

*39. Scaphiopus solitarius, Holbrook, Hermit Spade-Foot, Stratford.

*40. Bufo Americanus, Le Conte, American Toad, common.

*41. Hylodes Pickeringi, Holbrook, Pickering's hylodes, Stratford and Northford.

*42. Hyla squirella, Bosc., Little Squirrel Hyla, Massachusetts and New York.

*43. Hyla versicolor, Le Conte, Northern Tree Toad, common.

Family *Salamandridæ.*

*44. Salamandra fasciata, Green, Banded Salamander, common.

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*39. My specimen was found floating at the mouth of the Housatonic by Master D Giraud and brought to me alive. The moisture or liquid that exuded from its whole surface in twelve hours was almost incredibly great. It appears to correspond with Dr. Dekay's description, page 66 of his Report, but the toes of its hind feet being unlike his figure was a perplexity to me until I saw Dr. Holbrook's figure, which perfectly corresponds with my animal. It has all the peculiar marks of the Scaphiopus. Dr. Dekay asserts that it is found in great numbers at Salem, N. Y., which is near our state line, and it is therefore doubtless a denizen of Connecticut in other parts of this county.

*40. I would here remark respecting our common toad, that a few years since in autumn, when cutting down the tops of my dahlias, before removing the roots to sand for winter quarters, I found a large swell in a stalk near the ground perfectly closed, and without the least apparent orifice; but on cutting it open, out leaped a living toad of ordinary size and perfectly well. The only solution I could make of it was, that some insect must first have punctured the dahlia stalk, and in its rapid growth a small hollow must have been caused, into which the toad while young and small entered, and probably lodged for a day or so, and the rapid growth of the plant held him there until it surrounded him, and accommodated its growth to the incumbrance of the toad inside. But what supported the toad and thus increased his size, is not so plain.

*41. I have two fine specimens of this little lump of animal matter, presented me from Northford by my brother, Mr. John S. Linsley, of that place, where he took them. Mr. Wm. O. Ayres informs me that it has also recently been taken in East Hartford.

The *Hylodes grillus*, (*Cricket hyla,*) has according to Dr. Dekay been taken near New York, but I have not learned of its being yet found in New England, and have therefore omitted its insertion here.

*42. The little peeping hyla, called also squirrel hyla, has been taken in Roxbury, Mass. and near New York, as announced in the interesting Reports of Dr. Storer and Dr. Dekay. Dr. Holbrook however considers it exclusively a southern species, and if so, was probably *introduced* from thence to the northern and eastern states.

*43. The tree toad is found in every town in Connecticut, as far as I am acquainted; and its hoarse guttural cry is always considered an indication of rain, as I have for many years observed.

*44. Of this common species of salamander I have many specimens, no two of which are alike in their bands, but still so near alike as to make it certain they are

*45. Salamandra symmetrica, Harlan, Stratford.

*46. Salamandra erythronota, Green, Red-backed Salamander, common.

*47. Salamandra bilineata, Green, Striped Salamander, Orange.

*48. Salamandra subviolacea, Barton, Violet-colored Salamander, Huntington and Northford.

*49. Salamandra salmonea, Storer, Salmon-colored Salamander, Stonington.

*50. Salamandra millepunctata, Storer, Many-dotted Salamander, Stratford.

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the same species. The whole race of salamanders, as far as I have discovered, are not only perfectly harmless, but exhibit no signs of resistance when taken in the hand, except a great desire to escape.

*45. In many respects there is a great resemblance between the *symmetrica* and the *millepunctata*, though sufficient difference to characterize the species. It is found from Maine to Florida, as appears by different authors.

*46. The red-backed salamander is the most common of any of the species in Connecticut. I find it in nearly every town where I have visited and searched for *Helices* and *Pupas*, under decaying logs and stones. This animal is usually found with the *Helix arborea*.

*47. Of the striped salamander I have taken a specimen in the town of Orange, found under bark with *Helix monodon*, that answers well to Holbrook's description. The tail is more slender and longer in proportion to the whole length of the animal than that of the preceding species. Still I should not be surprised to find it eventually considered only a *variety* of the red-back.

*48. I have taken one specimen of the violet-colored salamander at Huntington, and received another from my brother at Northford, both of which correspond well with Dr. Dekay's and Dr. Holbrook's figures and descriptions as well as size. I have also another specimen seven and a half inches in length from the town of Trumbull, that differs very essentially from the other two. It was sent to me by Dr. E. Middlebrook in alcohol, into which it had been recently placed. It was found in company with several others which were said to be much larger. On this the spots are large, distinct, regular, and nearly parallel through the whole length of the back. I have seen no figure like it in any of the books except Catesby's (of 1772) on "the Natural History of Georgia, Florida, and the Bahama Islands." In that work (p. 110, fig. 2) is represented his "*Stellio aquaticus minor Americanus*," in the bill of a crane that answers very nearly to my animal with some slight differences in number of spots on the tail. His animal, however, was but five inches long—only two thirds the length of mine.

Although Barton's specific name of *venenosa* has the priority for this species, it is so inappropriate, his subsequent name adopted by Dr. Holbrook is preferred.

*49. Of the salmon-colored salamander, Mr. J. H. Trumbull of Stonington has taken a specimen this season, as he informed me by letter.

*50. The many-dotted salamander, erroneously considered by some naturalists the *dorsalis* of Harlan, is not very rare. I took five or six individuals as late in the season as November last, under pieces of timber on the borders of a pond, and sent two to Dr. Storer for the Boston Society of Natural History, and two to Mr. Cozzens, of the New York Lyceum of Natural History. It has also been taken at Ston-

*51. Salamandra picta, Harlan, Painted Salamander, East Hartford.

*52. Salamandra glutinosa, Green, Blue-spotted Salamander, Northford.

*53. Salamandra maculata, Green, Brown-spotted Salamander, Canaan.

*54. Salamandra tigrina, Green, Yellow-spotted Salamander, ?

*55. Salamandra longicauda, Green, Long-tailed Salamander, Salisbury.

Before concluding this article, I wish to remark respecting my "*Catalogue of the Birds of Connecticut*," that the few notes inclosed in brackets and signed "J. D. W.," were added after I had corrected and returned the proof-sheets, and were unknown to me until all the copies had been printed. I mention it here with a view to *explain* the apparent discrepancy in notes 71 and 72 of that list. The latter note had evidently not been noticed by Dr. J. D. W. He added the locality or habitat of "*New Haven*" after Stratford to more than eighty species, which rendered it necessary for the erasure of note 72.

I had added *New Haven* only to the rarer birds, though the Doctor had very kindly and obligingly furnished me with a list of such birds as he had previously found at New Haven, and for which due credit had been given in the introduction to my catalogue.

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ington, or the true *dorsalis*. It was supposed by Mr. Trumbull to be the latter. Mr. Wm. O. Ayres has also taken it (i. e. the *millepunctata*) at East Hartford.

*51. Mr. Ayres informs me this species has been taken at East Hartford.

*52. I obtained a specimen of the blue-spotted salamander at Northford in 1842.

*53. It is said by Dr. Dekay that this is the most common species in our country, and is supposed by Dr. Holbrook to be the *rubra* of Daudin. It is said to be not uncommon in the northwest portion of the state, as I am informed by many persons in that vicinity.

*54. Dr. Holbrook remarks, Vol. III, p. 110, that the *S. tigrina* is found in the northern states from New Jersey to Massachusetts.

*55. Mr. Frederick Plumb of Salisbury, and several other gentlemen in Canaan, Litchfield County, assure me they have found this beautiful and singular species in those towns. I saw a fine specimen in the New York Lyceum, (563 Broadway,) that I believe was taken near Albany.

All the salamanders herein named are not only harmless, and ought therefore not to be destroyed, except for useful preservation, but they consume immense quantities of insects, and ought therefore to be preserved for the good they actually accomplish.

I am happy now to add in regard to the birds of Connecticut, that the "*cliff swallow*," or as I should prefer to call it, *society swallow*, has been a resident of Connecticut for more than twelve years, as I am well informed by observing gentlemen in Litchfield County. I recently passed a great collection of them in Brookfield, where they have been for many years; and Wm. O. Ayres, Esq. also informs me, they have been two or three years in Hartford and its vicinity.

The Golden-winged Warbler (*Sylvia chrysoptera*) I saw last spring in my garden, and Mr. Ayres saw and obtained it in East Hartford, and also six specimens of the lesser *red-poll* out of hundreds seen at the place.

He also obtained a specimen of Cooper's Hawk and the little Corporal Hawk. I have also seen in Stratford the Rough-legged Hawk, (*Falco Sancti-Johannis* of Bonaparte, *F. lagopus* and *niger* of Wilson.)

Elmwood Place, Stratford, Nov. 1, 1843.

Postscript.—I have this day, (Nov. 13,) taken a species of tortoise not enumerated in the preceding list of reptiles, and probably never before found in New England. As it is too late to add this species to the Chelonidæ, (the sheet containing that family having gone to press,) it is inserted in this place.

***56.** Kinosternon Pennsylvanicum, Bell, Mud Tortoise, Stratford.

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*56. This is the *Testudo Pennsylvanica*, of Edwards, the *Cistuda Pennsylvanica*, of Say, the *Emys Pennsylvanica*, of Harlan, and the *Kinosternon Pennsylvanicum*, of Holbrook and Dekay. *Shell*, length 4 inches, width 2·6, depth 1·5 inches It is narrower in proportion to its length, than any of our tortoises, except *Sphargis coriacea*. The posterior portion of the shell being almost perpendicularly elevated, constitutes a very distinguishing feature of this animal, and will prevent its being taken for any other species. It is however the most nearly allied to the *Sternothærus odoratus*.

It has been asserted by naturalists, that the common toad casts its skin, and in proof of this fact I would remark that I was informed by the Rev. Mr. Smith of this town, that he once saw the common toad *cast his skin*, in the manner following. He began by scratching holes in the old skin with his hind feet on his sides, and by various movements and evolutions, he succeeded in getting the end of this skin into his mouth, and then by swelling like a bladder and at the same time pulling with his mouth and repeating the operation, alternately swelling and falling, he succeeded in pulling the whole into his mouth, and swallowing it. The appearance of the toad was thus changed from a filthy to a bright and shining animal. This operation is not new, but may serve to establish what to those who have not witnessed it, might appear doubtful. J. H. L.

Art. V.—*Remarks on the Theory of Compound Salt Radicals;* by Wolcott Gibbs.

1. In a memoir appended to the last edition of his Compendium of Chemistry, and republished in this Journal, Vol. xlv, pp. 52, 247, Dr. Hare has brought forward a number of powerful arguments against the doctrine of compound salt-radicals, which has recently made great progress among European chemists, and at present threatens to subvert all established theories and nomenclature, and to erect the superstructure of chemical science upon a foundation apparently far too unsubstantial to support its gigantic proportions and rapidly increasing weight. This theory sets out from a principle very different from any which chemists have been hitherto accustomed to admit, and which would seem to be involved in a philosophical idea of the province and objects of chemistry, since it aims at explaining a few superficial resemblances in purely *physical* properties, by making a total change in the *chemical* constitution of those substances between which such resemblances exist, as well as of innumerable others which display in their physical relations far more striking discordances. Thus the physical similarity between the chlorides, iodides, &c. of the alkaline and earthy metals, and the sulphates, nitrates and other oxysalts of the same metallic radicals, is made the basis of a total change in our views of the chemical constitution of all salts whatever, while the much more remarkable and more widely extended differences between other members of the same classes of compounds, so forcibly urged and so clearly illustrated by Dr. Hare, are left entirely unnoticed or swallowed up in the sweeping assertion that the salts of the simple haloid type, and the salts composed of amphacids and amphibases, form "a series of basic and acid compounds for the most part completely parallel."

2. The principal arguments which have been brought forward in favor of the salt-radical theory, which is in part based upon this assumed parallelism, have been ably discussed by Dr. Hare in the memoir above alluded to. In the present paper I propose to offer a few remarks upon some points to which the attention of chemists does not appear to have been particularly directed. For the sake of brevity I shall employ the terms *amphide* and *halide* to designate respectively the compounds of the amphigen and halogen bodies of Berzelius with electro-positive radicals,

while the term *ide*, from the terminal syllable of the words oxide, chloride, &c. will serve to embrace in a single group all amphides and halides whatever, whether acids or bases.

3. In the first place then it is remarkable, that while it is asserted in favor of the new theory, that a great number of what are termed oxyacids have *not* been obtained in an isolated state or uncombined with bases, the fact that the oxysalts themselves constitute but one out of four very numerous classes of salts, viz. sulphur-salts, selenio-salts and telluri-salts, and that without exception the sulph-acids, selen-acids and tellur-acids *have* been obtained uncombined with bases, is wholly neglected. Indeed the supporters of the new theory do not appear to have at all contemplated the effects of its extension beyond the comparatively narrow limits of the oxysalts, considered as forming a single family.

4. In the case of almost all those oxysalts in which the existence of an electro-negative oxyacid has not been demonstrated synthetically, a definite isolated amphide or halide exists, whose formula is precisely analogous to that which the hypothetic oxyacid would have if obtained in a separate state. Thus the existence of acetic, formic, benzoic and oxalic acids in the salts whose formulas are AcO_3+RO, FoO_3+RO, $BzO+RO$, C_2O_3+RO, may be inferred from the well known possibility of obtaining in an isolated state the chlorides, iodides, sulphides, &c. $AcCl_3$, $FoCl_3$, FoI_3, $BzCl$, BzS, BzI, C_2Cl_3, which obviously correspond to the hypothetic AcO_3, FoO_3, BzO, C_2O_3.

5. In the particular cases of nitric, chloric and bromic acids, no such parallel amphides or halides are known to exist, yet the argument from analogy is even in these cases hardly less strong. The isolable oxides of antimony SbO_3, SbO_4, SbO_5 are completely parallel to those of nitrogen NO_3, NO_4, NO_5, of which the first two may also be obtained in a separate state; and in like manner the existence of such compounds as ClO_5, and BzO_5, is rendered, to say the least, extremely probable, by that of the definite corresponding iodic acid, IO_5, whose compounds with oxybases so strongly resemble the chlorates and bromates.

6. In addition to the very forcible observation of Dr. Hare, that while *some* of the oxygen acids have not been isolated, *all* of the assumed salt-radicals are in the same predicament, it may be worth while to state that the assertion of Dr. Kane, that, of all known acids, those which have not hitherto been obtained uncombined with bases constitute a great majority, would be

very much too broad, even were it asserted of the oxyacids alone. These, as already observed, constitute, even upon the ordinary view, about one fourth of the whole number of those usually admitted by chemists. Whereas agreeably to the views of Bonsdorff, Hare and Thomson, in accordance with which, what are termed double chlorides, double iodides, &c. are really simple salts of halogen acids and bases, the oxysalts do not constitute the eighth part of the whole number of salts at present known and described. While if those saline substances, the electronegative ingredients of whose acids and bases are compound radicals like cyanogen, amidogen, or mellon, are taken into the computation, the number of the oxysalts becomes comparatively very small.

7. In the next place, while it is asserted that the hypothetical salt-radicals by combining with electro-positive substances form compounds exactly analogous in constitution to simple chlorides, iodides, &c., it has not been observed that if they indeed do so, they become precisely as similar to oxides and sulphides as to chlorides and halides generally. Since, till the new theory of salts began to occupy a prominent place in theoretical chemistry, the existence of a halide of any particular atomic constitution or type was deemed *a priori* almost a demonstration of the existence of amphides of the same type, and *vice versa*. So that if a protochloride and a sesquichloride of a new metallic radical were to be discovered, it might thence be immediately and certainly inferred that there were oxides, sulphides, selenides and tellurides, as well as iodides, bromides and fluorides of an exactly analogous composition. If therefore the formulæ, $M+SO_4$, $M+2SO_4$, M_2+SO_4, M_2+3SO_4, adduced by Prof. Graham, from their obvious analogy to those of simple chlorides, $M+Cl$, $M+2Cl$, M_2+Cl, M_2+3Cl, be considered as demonstrating the general molecular resemblance of the salts containing compound salt-radicals to the simple halides, they must also demonstrate their analogy to the oxides and sulphides whose formulæ are precisely similar, $M+O$, $M+2O$, M_2+O, M_2+3O, $M+S$, $M+2S$, M_2+S, M_2+3S.

8. The analogy between the compound electro-negative *ions* assumed in the new theory, to the simple halogen bodies, will be found upon close examination to be extremely superficial. If for instance the monobasic, bibasic and tribasic oxyphosphions PO_6, PO_7, PO_8, are analogous to chlorine, why should they be inca-

pable of combining in more than one proportion? Why have we not such compounds as $M+2PO_6$, $M+3PO_6$, $M+5PO_6$, $2M+7PO_6$, $2M+5PO_7$, $2M+7PO_7$, $3M+3PO_8$, $3M+5PO_8$, corresponding to $M+2Cl$, $M+3Cl$, $M+5Cl$, M_2+7Cl, M_2+7F? The instances of such agreement brought forward by Graham in regard to the oxysulphion SO_4, and cited in the last paragraph, go but a very little way toward establishing the complete parallelism asserted to exist between the two classes of compounds. No attempt is made by either Graham or Kane to carry out this assumption in the case of the bibasic and tribasic salt-radicals.

9. No simple substance whatever, whether amphigen or halogen, can be said to be either monobasic, bibasic, or tribasic. An amphigen or halogen body combines with but one or at most two equivalents of an electro-positive radical or basyle, and there is no such thing as assigning a *fixed* number of electro-positive atoms to any of the simple electro-negative ions.

10. It seems to have escaped notice that the phosphorous acid is tribasic as well as the phosphoric. This being the case, the formula of a phosphite PO_3+3MO becomes on the new view PO_6+3M. But that of a monobasic phosphate is also, on the same view, PO_6+M. Consequently the oxyphosphion PO_6 is both monobasic and tribasic; is not this at least as incomprehensible as that phosphoric acid should by some change in its molecular structure, perhaps by the doubling or trebling of its atomic weight, become capable of combining with one, two, or three atoms of base? Recourse must either be had to the doctrine of isomerism, and it must be considered that there are two oxyphosphions each of which has the formula PO_6 but of which one is monobasic and the other tribasic, or else the very same difficulty presents itself upon the new view which was formerly urged against the old. But it should be remembered that if such an explanation be admitted in the case of the salt-radical PO_6, it must be equally good in the case of the acid PO_5, and we may assume that there are three isomeric phosphoric acids respectively capable of combining with one, two, or three atoms of base.

12. The admirable researches of Graham on the constitution of salts, have demonstrated that one oxysalt enters into combination with another only by a replacement of its constitutional water. Thus the double sulphate of zinc and potassa $(ZnO,SO_3+KO,SO_3)+6Aq$ is formed from common sulphate of zinc, $(ZnO,SO_3+HO)+6Aq$ by the substitution of an atom of

sulphate of potash for an atom of water, the double sulphate of magnesia and potassa ($MgO,SO_3+KO,SO_3)+6Aq$, and innumerable other double salts by a precisely similar replacement, the crystallogenic water remaining constant. Hence it clearly appears that there exists between an oxysalt and an oxide of the magnesian family, an analogy so strong that they are capable of replacing one another in a third substance without altering its molecular type. If then there exists between a double oxysalt and a double chloride that perfect analogy which is asserted by the supporters of the new theory, it follows that one of the two chlorides enters into combination with the other only by replacing its water of constitution. Yet a careful comparison of the formulæ of the simple and double chlorides clearly shows that such is not the case. Even if it were so, it would only exhibit another argument against the salt-radical theory, since obviously it would then demonstrate that analogy between a simple chloride, as HCl, and a simple oxide, as HO, which is so obstinately denied by the advocates of the new view.

12. It appears to be a general law in chemistry, that the more simple the chemical constitution of a body, the more simple is its crystalline form. Thus simple substances, with but few exceptions, crystallize in the regular system. Anhydrous protohalides, as protochlorides, protocyanides, &c. almost universally appear crystallized in cubes or regular octahedrons. Anhydrous protoamphides in like manner, so far as our knowledge of them extends, assume the same forms; the protosulphides of lead, zinc, and silver, will serve as examples. On the other hand, when the simple molecule of metal assumes more than one atom of amphigen or halogen body, or when the protohalide or protoamphide combines with crystallogenic or constitutional water, it assumes a more complicated crystalline form and structure. Agreeably to this law the compounds of salt-radicals with metallic basyles should, when anhydrous, appear crystallized in the regular system, whereas on the contrary a close examination shows that this is very rarely the case. It appears then that the supposed resemblance between the two classes of salts, viz. the haloid salts and the salts of amphacids and amphibases, fails in a most material and striking manner when they are compared by the only exact standard of physical similarity which we possess—identity of crystalline form.

New York, October 23d, 1843.

ART. VI.—*An Abstract (from Kane's Elements,) of the Arguments in favor of the Existence of Compound Radicals in Amphide Salts.*

HAVING published Dr. Hare's *effort to refute the arguments advanced in favor of the existence of compound radicals in amphide salts*, it may be just, as respects those readers who have not access to Kane's Elements, to republish from that work the arguments in question. (See page 631.)

"It had been long remarked as curious, that bodies so totally different in composition as the compound of chlorine with a metal on the hand, and of an oxygen acid with the oxide of the metal on the other, should be so similar in properties, that both must be classed together as *salts*, and should give origin to series of basic and acid compounds for the most part completely parallel. This difficulty has been so much felt by the most enlightened chemists, that doubts have been raised as to whether the acid and base, which are placed in contact to form by their union an oxygen salt, really exist in it when formed; and it has been suggested, that at the moment of union a new arrangement of elements takes place, by which the structure of the resulting salt is assimilated to that of a compound of chlorine or of iodine with a metal. This view, at first sight so far-fetched, which considers that in glauber's salt there is neither sulphuric acid, nor soda, but sulphur, oxygen, and sodium, in some other and simpler mode of combination, is now very extensively received by chemists; and I shall proceed, therefore, to describe with some detail the form which it has assumed, and the evidence by which it is supported.

"The greater number of those bodies which are termed oxygen acids, have not been in reality insulated, and what are popularly so called are merely supposed to contain the dry acid combined with water. Thus the nearest approach we can make to nitric acid, is the liquid NO^6H; to acetic acid, the crystalline body $C^4H^4O^4$; and to oxalic acid, the sublimed crystals C^2O^4H; we look upon these bodies as being combinations of the *dry acid* with water, and we write their formulæ NO^5+HO, and $C^4H^3O^3+HO$ and C^2O^3+HO, but that these dry acids exist at all is a mere assumption. Hence with regard to these instances, and they embrace the majority of all known acids, the idea that the

acid and base really exist in the salt formed by the action of hydrated acids on a base, is purely theoretical.

"When we compare the constitution of a neutral salt with that of the hydrated acid by which it is formed, we find the positive result to be the substitution of a metal for the hydrogen of the latter, thus, SO^3+HO gives with zinc SO^3+ZnO; and where a metal is acted on by an hydrated acid, the hydrogen is thus evolved either directly as gas, or it reacts on the elements of the acid and gives rise to secondary products which are evolved, such as sulphurous acid, nitric oxide, &c. In all cases we may consider the action of a metal on a hydrated acid, to be primarily the elimination of hydrogen and the formation of a neutral salt. But in this respect the action becomes completely analogous to that of the metal on a hydracid, except that in the latter case a haloid salt is formed, and hence we assimilate the two classes in constitution by a very simple arrangement of their formulæ.

"There are, however, a number of acids which may be obtained in a dry and isolated form, as the sulphuric, the silicic, the telluric, the stannic, the arsenic, the phosphoric, &c., and when they combine with bases, it is most natural to consider the union as being direct, and that the salt contains acid and base really as such. This is accordingly the strongest point of the ordinary theory. But other and important circumstances intervene. These acids, although they may be obtained free from water, yet in that state they combine with bases but very feebly, and require a high temperature in order to bring their affinities into play. On the other hand, in all cases where these bodies manifest their acid characters in the highest degree, they are combined with water, as in oil of vitriol and phosphoric acid, and when expelled from combination with a base, they immediately enter into combination with water in an equivalent proportion. Thus where phosphate of lime is decomposed by oil of vitriol, it is not phosphoric acid (PO^5) which is found in the liquor, but its terhydrate (PO^5+3HO), as is shown by its forming with oxide of silver the yellow phosphate PO^5+3AgO. In the case of telluric acid, its hydrate (TeO^3+3HO) is very soluble in water, it crystallizes in large prisms; by 212° two atoms of water are given off, but its nature is not changed, the body which remains (TeO^3+HO) is still acid and soluble in water, perfectly neutralizing the alkalies; but by a red heat this last atom of water is driven off, and

then the whole nature of the body changes, it is insoluble in water, and even in the strongest alkaline solutions, and can only be brought back to its former state by being fused with potash at a red heat. Here it is evident that the acid properties and the water go together; and we may conclude, that in order to manifest strong acid properties, the acid must be in its hydrated form. But in that hydrated form, if the water acted as a base simply, the tendency of the acid to combine with other bases should be inferior to that of the dry acid; for if we place oil of vitriol and barytes together, the water must be first expelled before the barytes and sulphuric acid can unite, and hence an impediment would exist to their union which should not occur with cold barytes and dry sulphuric acid in vapor, and yet cold barytes and oil of vitriol will combine with such intensity as to produce ignition, whilst the barytes must be heated before it begins to combine with the dry sulphuric acid. The water, therefore, is essential to the manifestation of strong acid properties, and it does not exist in combination with the acid merely as a base. What, then, is the constitution of a hydrated oxygen acid?

"When muriatic acid (HCl) acts on zinc, the metal is taken up, forming ZnCl, and hydrogen is expelled, and if, in place of zinc, oxide of zinc be taken, the effect is the same, except that the hydrogen combining with the oxygen of the oxide forms water; HCl and ZnO giving ZnCl and HO. Now we have in oil of vitriol the elements SO^4H combined together; when put in contact with zinc, H is expelled, and SO^4Zn is formed, and with ZnO and SO^4H, there are produced SO^4Zn, and HO is set free. In both cases, of which the former may be taken as the type of all the haloid salts, and the latter of all salts formed by oxygen acids, there is H as the element which is removable by a metal, precisely as one metal is replaceable by another, as indeed from the real metallic character of hydrogen may be considered to occur in this case. Every acid may, therefore, be considered to consist of hydrogen combined with an electronegative element, which may be *simple*, as chlorine, iodine, fluorine; or may be compound, as cyanogen, NC^2, and yet capable of being isolated; or as occurs in the great majority of cases, its elements may be such as can only remain together when in combination. Thus oil of vitriol does not contain SO^3 and HO, but consists of hydrogen united to a compound radical SO^4. Liquid

nitric acid does not contain NO^5 and HO, but consists of hydrogen united to a compound radical NO^6, and the acetic acid is written $C^4H^3O^4+H$, the oxalic acid C^2O^4+H, and so on.

"The elegance and simplicity with which the laws of saline combination may be deduced from these principles is really remarkable. Thus it has been remarked as a fact substantiated by experiment, that in neutral salts the number of equivalents of acid were proportional to the number of equivalents of oxygen in the base, but the ordinary theory gave no indication of why this should occur. It follows necessarily from the principles of the newer theory. Thus, if a protoxide be acted on by an acid, M denoting the metal of the oxide, and R the radical of the acid, the resulting action is

$$M+O \text{ and } H+R, \text{ produce } H+O \text{ and } M+R,$$

and in the neutral salt there is an equivalent of each. Now in the case of a sesquioxide, in order that water shall be formed, and so neither acid nor base in excess, the reaction is that

$$M^2+O^3 \text{ and } 3(H+R), \text{ produce } 3(H+O) \text{ and } M^2+R^3,$$

a sesqui-compound being formed perfectly analogous to a sesquioxide, and the number of atoms of acid, $3(H+R)$, is equal to the number of atoms of oxygen in the base (M^2O^3), because that number of atoms of hydrogen are required for the decomposition of the base. In like manner for a deutoxide, there is

$$M+O^2 \text{ and } 2(H+R), \text{ producing } 2(HO) \text{ and } M+R^2.$$

The power of salts to replace water in the magnesian sulphates, so as to form double salts, becomes much more intelligible when we compare $H+O$ with $K+SO^4$, than where HO was contrasted with the complex formula $KO+SO^3$.

"The circumstance that on the new theory (or as it is now often called, the *binary theory of salts*,) it is necessary to admit the existence of a great number of bodies (these *salt radicals*) which have never been isolated, and in favor of whose existence there is no other proof than their utility in supporting this view, becomes more powerful as an objection, when we proceed to apply its principles to the salts of phosphoric acid. For it has been already described, that this acid forms three distinct classes of salts, all neutral, and which have their origin in the three hydrated states of the phosphoric acid. These states are written on the two views as follows:—

	Old theory.	New theory.
Monobasic acid,	PO^5+HO	PO^6+H
Bibasic acid,	PO^5+2HO	PO^7+H^2
Tribasic acid,	PO^5+3HO	PO^8+H^3

"Now it appears very useless, where the older view accounts so simply for the properties and constitutions of these salts, to adopt so violent an idea, as that there are three distinct compounds of phosphorus and oxygen which no chemist has ever been able to detect. But here again other circumstances must be studied; first, the difference of properties of phosphoric acid, in its three states, is totally inexplicable, on the idea of their being merely three degrees of hydration. Nitric acid forms three hydrates, but when neutralized by potash, it always gives the same saltpetre; sulphuric acid forms two perfectly definite hydrates, but with soda forms always the same glauber's salt; whilst phosphoric acid, when neutralized by soda, gives a different kind of salt according to the state it may be in. Also, the permanence of these conditions of phosphoric acid is a powerful proof that they do not consist in the adhesion of mere water. The idea that the phosphoric acid is a different hydracid in each of its three conditions, on the other hand, not merely explains the fact of these differences of properties, but it renders the formation of bibasic and tribasic salts, which is such an anomaly on the old theory, a necessary consequence of the new, for the phosphoric salt radicals, PO^6, PO^7, and PO^8, differ not merely in the quantity of oxygen they contain, but are combined with different quantities of hydrogen, and hence in acting on metallic oxides (bases), there is a different number of atoms required for each to replace the hydrogen and form water. Thus—

$PO^6.H$ and NaO give HO and $PO^6.Na$. monobasic phos. of soda,

$PO^7.H^2$ and 2NaO give 2HO and $PO^7.Na^2$. bibasic phosphate,

$PO^8.H^3$ and 3NaO give 3HO and $PO^8.Na^3$. tribasic phosphate.

A circumstance which gives additional reason to infer that the water is not merely as base in the phosphoric acid, is the following: if it were so, then it should be most completely expelled by the strongest bases, and the bibasic and tribasic phosphates of the alkalies should be those least likely to retain any portion of the basic water; but the reverse is the fact; whilst oxide of silver, a very weak base, is that which most easily and totally replaces the water. On the idea, however, of hydracids, this is

easily understood, for the oxide of silver is one most easily reduced by hydrogen, and consequently one on which the action of a hydrogen acid, as PO^3+H^3, or PO^7+H^3, would be most completely exercised.

"A remarkable verification of this theory has been recently found in the decomposition of solutions of the oxysalts in water, by voltaic electricity. It has been already explained (pp. 314 *et seq.*) that it requires the same quantity of electricity to decompose an equivalent of any binary compound, such as iodide of lead, chloride of silver, muriatic acid, or water. Now, if we dissolve sulphate of soda in water, and pass a current of voltaic electricity through that solution, we have water decomposed, and also the glauber's salt; oxygen and sulphuric acid being evolved at one pole, and soda and hydrogen at the other. Here, on the old view, the electricity performs two decomposing actions at the same time, and, as it thus divides itself, its action on each must be lessened, and the quantity of each decomposed be diminished, so that the sum should represent the proper energy of the current. On measuring these quantities, however, the result is totally different, the quantity of sulphate of soda decomposed is found to be equal to the full duty of the current, and an equivalent of water appears to be decomposed in addition. It is quite unphilosophic to imagine, that the strength of a current should be thus suddenly doubled, and a simple and sufficient explanation of it is found in the new theory of salts. The sulphate of soda in solution having the formula $NaSO^4$ is resolved by the current into its elements, Na and SO^4, as chloride of sodium would also be; the sodium, on emerging at the negative electrode, from the influence of the current, instantly decomposes water, and soda and hydrogen, of each an equivalent, are evolved; at the positive electrode the compound radical So^4 also decomposes water, and produces $H.SO^4$ and O. The appearance of the oxygen and hydrogen is thus but secondary, and the body really decomposed by the current is only $Na\ So^4$.

"In the case of the salts of such metals as do not decompose water, the phenomena are much more simple. Thus a solution of sulphate of copper, when decomposed by the battery, yields metallic copper at the negative, and sulphuric acid and oxygen at the positive electrode, and the quantity of copper separated represents exactly the energy of the current which has passed, for

the salt being $Cu.SO^4$, is simply resolved into its elements, but SO^4 reacting on the water, produces $H.SO^4$ and O at the positive electrode. On the old view, it was supposed that water and sulphate of copper were both decomposed, oxygen and acid being evolved at one side, and oxide of copper and hydrogen being separated at the other; which reacting produced water and the metal. Such an explanation, however, is directly opposed to the law of the definite action of electricity, and cannot be received.

"In the case of solutions of chlorides or iodides, where there can be no doubt of the relations of the elements, the results of voltaic decomposition are precisely similar. Chloride of copper gives simply chlorine and copper, no water being decomposed. Chloride of sodium or iodide of potassium give chlorine or iodine at the one electrode, and alkali and hydrogen at the other; the evolution of these last being caused by the action of the metallic basis on the water of the solution.

"Professor Daniell, to whom these important electro-chemical researches are due, considers the truth of the binary theory of salts to be fully established by them.

"If this theory be adopted, a profound change in our nomenclature of salts will become necessary. Graham has proposed that the name of the salt radical should be formed by prefixing to the word *oxygen* the first word of the ordinary name of the class of salts, and that the salts be termed by changing *oxygen* into *oxides*. Thus SO^4 *sulphatoxygen*, gives sulphatoxides, the sulphates. NO^6 nitratoxygen, gives nitratoxides, the nitrates, and so on; but I consider that the form of nomenclature proposed by Daniell deserves the preference. It has been described (p. 314) that Faraday proposed to term the elements which pass to the electrodes of the battery, *ions;* acting on this, Daniell proposes to term the electro-negative element of the sulphates *oxysulphion*, that of the nitrates *oxynitrion*, and so on, and the salts may be termed oxysulphion of copper, oxynitrion of sodium, &c. It would be desirable, however, for a long time, to introduce these names only where theoretical considerations rendered their employment decidedly useful, and hence, in all future description of the salts, I shall make use of the language of our ordinary views, and treat of their preparation and composition without any reference to the discussion in which we have been engaged.

"The general adoption of the binary theory of salts has deprived of much of its interest and importance a question, which some years since was very ingeniously discussed, viz.—whether, in the formation of double salts, the salts which unite had the same relation to each other that acid and base were then thought to have. Thus it was supposed that the electro-negative qualities of sulphuric acid being less controlled by oxide of copper than by potash, the alkaline sulphate acted as a base to the sulphate of copper, when these two salts combined to form the double sulphate of potash and copper, and so on in other instances; but in addition to the circumstance that all we have said as to the constitution of the salts militates against this view, we have the positive evidence that, first, these double salts are formed not by combination merely, but by replacement of the constitutional water of the sulphates of the copper or magnesian class, which water nobody would contend to act in them as a base; and second, that when a solution of such a double salt is decomposed by the battery, the two salts are not separated as if they were acid and base, but are decomposed independently in the proportions of an equivalent of each, making together the sum of the chemical energy of the current.

"A similar idea was advocated by Bonsdorff regarding the double chlorides, iodides, &c. He proposed to consider the chlorides of gold, platina, mercury, &c. as chlorine acids, and those of potassium, &c. as chlorine bases, and so with the iodides. This view, however, although at first very extensively adopted, has given way to the gradual growth of knowledge. There is no analogy between a dry oxygen acid and a chloride; but the chlorides are in perfect analogy with the neutral salts. Thus CuCl does not resemble SO^3, but $Cu.SO^4$ and $CuCl+KCl$ is analogous not to $SO^3.KO$, but to the double salt $Cu.SO^4+K.SO^4$. Bonsdorff's idea was exactly counter to the direction of truth; he sought to bring all salts under the one head, by extending to all the constitution of oxygen acids and oxygen bases, whilst the progress of science has led us to the opposite generalization of reducing all salts to the simple haloid type."

Respecting the Isomeric Acids of Phosphorus.

A very important modification has been made with respect to the three isomeric states of phosphoric acid. They are inferred

to differ from each other *only* in the proportions of water, or other base which they require severally for their saturation; so that there is a monobasic, a bibasic, and tribasic phosphoric acid. When in the state heretofore designated as *free*, they are considered as constituting three phosphates of water. This assumed constitution of these isomeric acids has been represented by Dr. Kane, and other respectable chemists, as affording strong evidence of the existence of compound radicals in certain salts. Dr. Hare has in arguing against the existence of such radicals, adverted to the constitution of the different phosphates of water.* Hence it is deemed expedient to give, in the language of Dr. Kane† an account of the acids of phosphorus to which reference is made, and of their habitudes with basic water and other bases.

"The phosphoric acid has a great affinity for water, combining with it almost explosively. It may form three distinct compounds, *phosphates of water*, the constitution of which is as follows:—

Monobasic phosphate of water, - -	PO^5+HO.
Bibasic phosphate of water, - -	PO^5+2HO.
Tribasic phosphate of water, - -	PO^5+3HO.

"This relation was first established by the researches of Graham. Phosphoric acid combines not only with water in these three proportions, but each of them is a type of a series of salts, which the phosphoric acid is capable of forming. Thus there is a class of *monobasic phosphates*, another class of *bibasic phosphates*, and a third, which is the most common, of *tribasic phosphates*; the water contained in the phosphates of water being replaced to a greater or less extent, by means of equivalent proportions of ammonia or metallic oxides.

"A solution of phosphoric acid in water, may contain any one of the three phosphates of water that have been described, and when neutralized by bases may hence produce totally different salts. The properties of a solution of phosphoric acid may, therefore, be totally different according to the manner in which it had been prepared, and hence this acid was at one time ranked as a remarkable instance of isomerism; but Graham has beautifully shown, that the difference of properties is only the result of the

* See Effort to refute the arguments in favor of the existence in amphide salts of a compound radical like cyanogen.

† Elements, page 485.

existence of the different states of combination in which the phosphoric acid actually exists. It will consequently be necessary to study separately the properties of the three compounds of phosphoric acid with water.

"*Monobasic phosphate of water.*—A solution of this body reacts powerfully acid, it precipitates albumen (white of egg) in white curds; when neutralized by a base, it gives salts which contain but one atom of base, their formula being PO^5+RO; and a soluble salt of it produces in solutions of silver, a white, soft precipitate, PO^5+AgO. This is the least stable of the phosphates of water, it gradually passes into the other forms, particularly when its solution is boiled.

"*Bibasic phosphate of water.*—This form of the acid may be prepared by decomposing bibasic phosphate of lead by sulphuretted hydrogen. It is characterized by combining always with two equivalents of base, forming salts, whose formula is PO^5+2RO; its salts give, with nitrate of silver, a white precipitate PO^5+2AgO, which is not pasty like the monobasic phosphate. The salts of this acid may contain only one equivalent of fixed base, the other being water, and may hence at first sight appear to be constituted like the monobasic salts; the basic water is, however, easily known to be present, by its not being expelled by a moderate heat, with the water of crystallization, but requiring a temperature approaching to ignition for its expulsion.

"*Tribasic phosphate of water.*—This is the form of phosphoric acid which represents the class of salts most generally known; it is characterized by not precipitating albumen, and by combining with three equivalents of base when fully neutralized. In the majority of cases of the three equivalents of base, one is water; thus the common phosphate of soda is a tribasic phosphate, its formula being $(PO^5+2NaO.HO)+24Aq$; when moderately heated, or even by long exposure to dry air, it loses the 24Aq. but it requires to be melted at a red heat, in order to drive off the twenty fifth atom of water; and if this be done, on redissolving the fused mass in water, it crystallizes in a totally different form, and is found to have been changed into bibasic phosphate of soda, the formula of which is $(PO^5+2NaO)+10Aq$. The difference is remarkably shown by the action of these salts on a solution of silver; common phosphate of soda precipitates nitrate of silver of a canary yellow, and the solution becomes acid; one equivalent

of tribasic phosphate of soda, decomposing three equivalents of nitrate of silver, producing one equivalent of tribasic phosphate of silver, two of nitrate of soda, and one of nitrate of water; this last being liquid nitric acid, of course renders the liquor acid. The reaction may be simply expressed

$$PO^5 + 2NaO.HO \text{ and } 3(NO^5 + AgO)$$

$$\text{give } PO^5 + 3AgO \ldots 2(NO^5 + NaO) \text{ and } NO^5 + HO.$$

If on the other hand, bibasic phosphate of soda be used, the liquor remains neutral, for $PO^5 + 2NaO$ and $2(NO^5 + AgO)$ give $PO^5 + 2AgO$ and $2(NO^5 + NaO)$.

"In the tribasic phosphates, it frequently occurs, that there shall be but one equivalent of fixed base, the other two being water; such salts have frequently an acid reaction, and were formerly called biphosphates. Thus one tribasic phosphate of soda is $PO^5 + NaO.2HO$; the biphosphate of ammonia is tribasic, its formula being $PO^5 + NH^4O.2HO$.

"These salts of phosphoric acid were originally designated by Graham, metaphosphates, pyrophosphates, and common phosphates."

ART. VII.—*On the Volume of the Niagara River, as deduced from measurements made in* 1841 *by Mr. E. R. Blackwell, and calculated by* Z. ALLEN.

VERY little attention appears to have been hitherto bestowed on the investigation of the comparative volumes of water discharged by the great rivers of the globe. The relative amount of the evaporation and drainage from the soils of different countries in proportion to the quantity of rain that falls upon each, as denoted by rain-gauges, is also another interesting subject connected with the preceding one; for by measuring the quantity of water discharged from a region of country by the streams that drain it, and by deducting this quantity from the whole amount that falls upon it as indicated by rain-gauges, the relative amount of evaporation may be ascertained. The investigation of these facts forms the basis of a branch of the science of hydrography, and leads to many useful as well as curious and interesting enquiries.

Whilst passing a few days at the Falls of Niagara, in the summer of 1841, it occurred to me to make the necessary admeasure-

ments for ascertaining the quantity of water precipitated by the grand cataract, and drained from the vast area of country bordering on the great lakes of North America. This subject has long remained a matter of mere conjecture, although unusual facilities are offered for making the admeasurement of the volume of this majestic river, from the circumstance of its issuing from Lake Erie in an average equalized current throughout the various seasons of the year, unaffected by the droughts of summer and the floods of winter. In order to ascertain the average volume of water discharged by most other rivers of the earth, it becomes necessary to multiply a great number of observations during the several seasons of the year. But the flow of the Niagara River remains always nearly the same, varying only from the action of the winds on the surface of Lake Erie, and from a periodical succession of several rainy or dry years in the broad regions of the upper lakes.*

The results of the admeasurements of the volume of water of Niagara River, are now submitted, with the hope that they may furnish facts in this branch of the science of hydrography, which will be used as data by scientific men for various calculations;

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* It appears from the best information I was enabled to obtain, that a strong breeze or gale on Lake Erie, in the direction of the outlet of this lake, will cause the waters to become heaped up at that end, so as to produce a rise of the level of about two feet; and a corresponding rise of the Niagara River. A subsidence of the level of the surface to an equal extent occurs, whenever a gale takes place in an opposite direction, making a total variation of about four feet in the rise and fall of the level of the river, from the simple action of the wind on the surface of the lake. These changes of level have sometimes taken place in the course of a few hours. A nearly equal, but more gradual change of level, is produced, as before stated, by the alternations of a period of several rainy years followed by a period of successive years of comparative drought.

The descent of the waters of Niagara River, from the outlet of Lake Erie, is at first so considerable, as to cause the flow of the current to become accelerated to a velocity of about eight miles per hour. By means of an embankment constructed parallel with the shore along the margin of the river, the level of the surface of Lake Erie is maintained, or upheld, throughout a distance of several miles, above the level of the descending stream. This embankment serves to form a portion of the Erie Canal, and also to convey a supply of water to several large flour-mills at Black Rock, thus affording an efficient fall of about five feet.

From the general levelness of the low banks of the river between Black Rock and Lewiston, it appears probable that water power to any extent that ever will be required, may be obtained by diverting the water of the Niagara River over the table land adjacent to its bed; and that mills might there be erected sufficient to grind all the wheat produced on the broad regions of country, whose tributary waters swell the great lakes and the Niagara, affording unrivalled facilities for transporting the wheat to these mills.

and with the hope, also, that others may be induced to commence a system of similar admeasurements of the other great rivers of the earth, such as the Mississippi, Ganges, &c., which may form a basis of comparison of their relative magnitudes.

I have also subjoined some calculations, from which it will appear, that the motive power of the cataract of Niagara exceeds by nearly forty fold, all the mechanical force of water and steam power, rendered available in Great Britain, for the purpose of imparting motion to the machinery that suffices to perform the manufacturing labors for a large portion of the inhabitants of the world, including also the power applied for transporting these products by steam boats and steam cars, and their steam ships of war to the remotest seas. Indeed it appears probable that the law of gravity, as established by the Creator, puts forth in this single waterfall more intense and effective energy, than is necessary to move all the artificial machinery of the habitable globe.

In order that confidence may be placed in the estimates now presented, it may be proper to subjoin a statement of the modes in which the admeasurements were made, and the calculations based upon them were accomplished.

After having personally, and with much labor, sounded the fearfully rapid current of the Niagara River above the falls, at Black Rock, where the bottom, or bed, appears to be nearly level from one side to the other, and the depth about thirty two feet; and having repeated a course of similar admeasurements below the falls, at Queenston, where the current is more placid and the depth in the deepest place about one hundred and sixty feet; and after having lost an anchor in the course of these experiments, I finally found it necessary to have recourse to the aid of an engineer, in order to perfect all the admeasurements, which my limited time would not allow me to complete. For this purpose the services of Mr. E. R. Blackwell of Black Rock, a most skillful and accurate engineer, were engaged by me. His residence at that time, in the immediate vicinity of Black Rock, enabled him, with his zeal for the accomplishment of this object, to devote much time to completing an exact survey. By reference to the annexed sketch reduced from his elegant map of a section of Niagara River opposite Black Rock, it will be observed that thirty eight soundings were taken in three distinct ranges or lines across the channel of the river, each of the ranges being at the distance

CANADA

1626 feet — 1686 feet — 1783 feet

1650 feet.—12 feet.

1581 feet.—13 feet.

1546 feet.—22 feet.

1533 feet.—22 feet.

1516 feet.—13 feet.

1403 feet.—30 feet.

1331 feet.—24 feet.

1310 feet.—20 feet.

1307 feet.—30 feet.

Surface velocities. — *Surface velocities.*

7¼ miles per hour. — 5 10/11 miles per hour.

1181 feet.—26 feet.

1178 feet.—24 feet.

1155 feet.—34 feet.

1147 feet.—26 feet.

1097 feet.—29 feet.

1094 feet.—32 feet.

6 9/11 miles per hour. — 6 miles per hour.

1057 feet.—28 feet.

1018 feet.—32 feet.

984 feet.—32 feet.

923 feet.—28 feet.

NIAGARA RIVER. → N.

812 feet.—28 feet.

8 miles per hour. — 7¼ miles per hour.

752 feet.—32 feet.

652 feet.—32 feet.

640 feet.—28 feet.

6 10/11 miles per hour. — 5 5/7 miles per hour.

577 feet.—28 feet.

551 feet.—28 feet.

534 feet.—30 feet.

495 feet.—30 feet.

490 feet.—24 feet.

419 feet.—24 feet.

6⅔ miles per hour. — 6 miles per hour.

362 feet.—22 feet.

341 feet.—30 feet.

292 feet.—30 feet.

220 feet.—23 feet.

219 feet.—28 feet.

172 feet.—28 feet.

162 feet.—21 feet.

55 feet.—20 feet.

20 feet.—20 feet.

20 feet.—22 feet.

Pier

Black Rock Harbor

Erie Canal

of six hundred and sixty feet apart.* After thus obtaining three cross sections of the volume of the current, whereby its area or dimensions were ascertained, the velocity of the surface was then found in ten different places between these three lines, by noting the time in which floating bodies set adrift in different parts of the width of the river, were borne down from one sectional line to the distance of six hundred and sixty feet to the next sectional line below it. All these admeasurements were made with every attention to accuracy.

Having thus found by experiment the velocity of the surface of the stream, the average or mean velocity of the bottom and middle, as well as of the surface, was ascertained by means of the formula established by Eytelwein $\left(V=\frac{v}{10}\times 9\right)$ which for measuring the volume of water flowing in rivers of great depth, I consider to be a closer approximation to accuracy than those established by Prony and other philosophers, who have investigated the subject of the discharge of water flowing down the inclined planes of the beds of rivers. These calculations have been carefully revised; and the results stated may therefore be deemed as a sufficiently accurate estimate of the volume of water that flows from Lake Erie.

Allowing about 374,000 cubic feet of water (by estimate) to flow through the harbor of Black Rock per second, as indicated on the map, the results of these calculations show, that about 22,440,000 cubic feet, or 167,862,420 gallons, weighing 701,250 tons, or 1,402,500,000 lbs. of water, flow out of Lake Erie every minute, and become precipitated over the cliffs of rocks at the grand cataract of the Falls of Niagara.

Estimating the perpendicular descent of the waters of the grand cataract to be one hundred and sixty feet, and making the usual allowance of one third part for waste of effective power in the practical application of water to water-wheels; and also estimating the power of a horse to be equal to a force that will raise a weight of 33,000 pounds one foot high in one minute, which is Watt and Boulton's standard, we obtain the following results:

* In the preceding map the left hand column of figures in each section represents the distance of each sounding from the American shore, and the right hand column the depth of the soundings. The distance of the soundings from each other may be found by subtracting each measurement from the one next above it. The arrow denotes both the direction of the current and the point of compass.

$$\left\{\frac{1{,}402{,}500{,}000 \text{ lbs. of water} \times 160 \text{ feet of descent}}{33{,}000}\right\} - \frac{1}{3} = 4{,}533{,}334$$

horse-power, which is the measure of the mechanical force, or motive power, that the waterfall of Niagara is capable of imparting.

It has been estimated by Mr. Baines, in his history of the Cotton Manufactures of the United Kingdom of Great Britain in 1835, that the motive power employed to operate the machinery of all the cotton mills in Great Britain, was then equal to that of about

33,000 horses, imparted by the agency of steam.
11,000 " " " waterfalls.
100,000 horse power he estimated to be employed to operate the the woolen, flax, and other mills and mechanical operations.
50,000 horse power for propelling the machinery of steamboats and coal mines.
194,000 horse power in 1835.

Supposing about twenty per cent. to have been added to to this motive power in the increase of locomotive engines for railways and steamboats, as well as for various
39,000 manufacturing purposes, since 1835, we add to this aggregate 39,000 horse power more.
233,000 horse power may be taken to be the aggregate of motive power of all the steam engines and improved waterfalls of Great Britain; which, it will be perceived, is only one nineteenth part of the effective water power of Niagara falls.

When it is considered that the water power of the cataract of Niagara is unceasing, by night as well as by day, and that the power as calculated above for practical purposes in Great Britain is only applied on an average about eleven hours per day, during six days of the week, it may be assumed that the motive power of Niagara falls is at least forty fold of the aggregate of all the water and steam power employed in Great Britain; and probably equal to the aggregate of all the motive power employed for mechanical purposes on this earth.

The surface of Lake Erie is found to be three hundred and thirty one feet above the level of the surface of Lake Ontario, and five hundred and sixty five feet above that of the ocean. The descent of the waters of Niagara River in the few miles of distance between Black Rock and Queenston, is about one hundred and seventy one feet, exclusive of the grand cataract itself, forming a succession of rapids, which in some places present to view the

Fossil Footmarks from Turners Falls, near Greenfield Mass

sublime spectacle of the agitated surface of the ocean in a storm; and these rapids continue to occur during the subsequent descent of the river St. Lawrence, from the level of Lake Ontario to that of the sea, making in the aggregate above threefold of the waterfall of the grand cataract, and consequently one hundred and twenty fold of all the physical power derived from the use of all the waterfalls and steam engines employed as above stated in Great Britain, omitting to take into account the several huge rivers that are tributaries of the St. Lawrence. Such, and on so great a scale, are the ordinary operations of the impulses of physical power employed in the "mechanics of nature," in governing the movements of the waters of a single river, exceeding many fold the portion of physical forces rendered available and employed by all the inhabitants of the earth, as a motive power in the "mechanics of the arts." There is thus furnished an impressive lesson to humble the pride of man in his boasted achievements of the triumphs of mind over inert matter. It is well that these considerations should occur to the spectator, whilst he regards the cataract of Niagara; for no where is there exhibited on this earth a more impressive spectacle of the display of energetic physical power. Cold and indifferent, indeed, to the highest attributes of omnipotent excellence must be the mind of that human being, who can raise his eyes from the contemplation of this sublime work of nature, without a glow of fervent admiration of the "might, majesty and power" of nature's God.

Providence, R. I., Sept. 15, 1843.

ART. VIII.—*On the Fossil Footmarks of Turner's Falls, Massachusetts;* by JAMES DEANE, M. D.—(with a plate.)

THE fine cataract of the Connecticut River that bears the name of Turner's Falls, occurs soon after the entrance of this stream upon the limits of Massachusetts. It receives this distinctive appellation in memory of a military commander, who in the time of Philip's wars, with the loss of a single man of his party, slaughtered in this place three hundred Indians in one encampment. It was however a brief triumph, for he was cut off and slain in his retreat from the contest of extermination. Unlike the prevailing quietness that distinguishes this lovely river, in its passage through the

alluvial plains of Massachusetts and Connecticut, it is here in the distance of a few miles, precipitated over three successive cataracts with intermediate rapids. The scenery of Turner's Falls is unsurpassed in New England for picturesque beauty. From an eminence below the falls, the eye commands a fine view of the cataract and surrounding hills. The river emerges into view a short distance above the rocky barrier, where its surface is still as a mountain lake, but below this boundary, having fallen over it with a power that makes the earth tremble, it rushes over the rocks in an opposite direction, and is immediately lost in the chasms of the hills. The narrow compass of the horizon and an air of solitude that pervades the region, is in full contrast with the expanded valley and quiet loveliness that reigns undisturbed above and below the falls, which have been appropriately called the miniature of Niagara.

To the geologist it is a centre of peculiar attractions. He can here witness the junction of trap and sandstone under most favorable circumstances, the contact being perceptible for the space of a mile. The eastern limit of the sandstone basin is bounded by regions of granite, and the western by hills of mica slate, while in the northern neighborhood beds of limestone and primitive slates occur. Thus in an area of a few miles, no less than six distinct rock formations occur. An examination of the cataract seems to leave no doubt that its rocky structure was heaved up by the mechanical agency of the igneous rock which is in close proximity and parallel with it. The direction of the fall is irregular, but at intervals there are several eminences, which are crowned with diminutive trees. When the river passes the falls, it strikes directly against the trap or greenstone dyke, which gives a new direction to its current.

But the intent of this paper is to notice some peculiarities of the sandstone beds thus uplifted from their original positions, inasmuch as the exploration of their strata reveals the existence of *birds* at a period of time coeval with the deposition of this ancient rock. The readers of this Journal are already aware that their existence during this remote geological epoch is now fully established, and it is to carry on the illustrations, and accumulate the facts that bear upon this very interesting subject, that it is still presented. And it is perhaps doubtful if any locality of fossil footmarks furnishes such pure examples, as that of Turner's

Falls, although unfortunately it is the least prolific of all. By glancing at the plate it will be seen that the essential characters of the feet of living birds, are accurately demonstrated, and the analogy is calculated to fill us with astonishment. How an impression of a fleshy foot could have been made in yielding clay, and to the minutest touch preserved through a period of time so vast, seems without deep reflection to be incomprehensible; yet these are living witnesses that not only prove the immutability of the creative design, but reveal to us a faithful page in the history of the earth long, long antecedent to the creation of man.

It is rare to find a stratum containing these footprints exactly as they were made by the animal, without having suffered change. They are usually more or less distorted or obliterated by the too soft nature of the mud, the coarseness of the materials, and by many other circumstances which we may easily see would deface them, so that, although the general form of the foot may be apparent, the minute traces of its appendages are almost invariably lost. In general, except in thick-toed species, we cannot discover the distinct evidences of phalangeal structure of the toes, each toe appearing to be formed of a single joint, and seldom terminated by a claw. But, a few specimens hitherto discovered at this locality, completely developed the true characters of the foot, its ranks of joints, its claws and integuments. So far as I have ever seen, the faultless impressions are upon shales of the finest texture, with a smooth glossy surface, such as would retain the beautiful impressions of rain-drops. This kind of surface containing footmarks is exceedingly rare; I have seen but few detached examples, until recently it has been my good fortune to recover a stratum containing in all more than one hundred most beautiful impressions of the feet of four or five varieties of birds, the entire surface being also pitted by a shower of fossil rain-drops. By reference to the plate, it will be perceived that the fragments of this stratum are arranged in three distinct examples, correctly delineated upon a scale of one inch to one foot. The slabs are perfectly smooth on the inferior surface, and are about two inches in thickness.

In the examination of these splendid relics, the first impression of the mind is astonishment at the perfect preservation of the impressions, their wonderful fidelity to nature, and the harmony that prevails among so many lines of footsteps occurring upon such nar-

row dimensions. Numerous as they are, there is yet no confusion, the successive footsteps of each row bearing a just relation to each other. There appear to be three principal varieties, or perhaps sizes of impressions, each of which is accurately illustrated by the drawings, which were taken by my own hand. It is not however strictly easy to decide that these are after all distinct varieties, for setting aside the difference in size, there is great resemblance in them, yet in other respects they appear to be distinct, as is indicated by the relative length of stride and some other peculiarities. The large foot, which has received the name of *Ornithichnites Fulicoides*, (Trans. Assoc. Am. Geol. Vol. I, p. 258,) has an average length of stride of rather more than twelve inches, while the middle size, one fourth as large, has a stride of twenty to twenty three inches! It will also be seen from the plate that the zigzag direction of the steps of the *O. Fulicoides*, indicates a heavy short-legged bird, the centre of gravity falling far within the inner toe, while this line passes through or very near the centre of the other. This therefore seems to point out that the bird must have had relatively very long legs, unless we suppose, what is quite possible, that this was the running gait of a young bird. The small track is very beautiful; it is feebly impressed, from which we may infer that it was a light bird, yet in the anatomy of the feet and the great distance these organs are separated, it bears a strong affinity to the *O. Fulicoides*. Whether these birds were or were not distinct species, they were nevertheless gregarious in their nature, as is shown by the fact that they traversed the region together, and if we separate them into generic classes, it must be upon the nicest discrimination, although the structure of the foot is so beautifully cast.

The impression of a medallion is not more sharp and clear than are most of these imprints, and it may be proper to observe that this remarkable preservation may be ascribed to the circumstance that the entire surface of the stratum was incrusted with a layer of micaceous sandstone, adhering so firmly that it would not cleave off, thereby requiring the laborious and skillful application of the chisel. The appearance of this shining layer, which is of a gray color, while the fossil slab is a dark red, seems to carry the probability that it was washed or blown over the latter while in a state of loose sand, thus filling up the footprints and rain-drops, and preserving them unchanged until the present day—unchanged

No II
No 1
J. Deane del.
on Stone by W. Sharp

in the smallest particular, so far as relates merely to configuration, nothing being obliterated; the precise form of the nails or claws and joints, and in the deep impressions, of the metatarsal or heel bone, being exquisitely preserved.

The great slab, which is about six by eight feet in dimensions, contains over seventy five impressions. There are five rows of *O. Fulicoides* of five and six tracks each, three rows of the medium size of four tracks each, one row of the small size of fourteen consecutive impressions, and another row of a like number, made when the material of the slab was too soft to retain the peculiarities of structure, besides several other rows varying from two to six impressions each. It is a singular circumstance that of this great number, two or more footsteps, with perhaps one or two exceptions, nowhere fall upon the same spot.

The next slab in importance contains three rows of *O. Fulicoides* of three and four impressions each, one of the second size of two, and one of the smallest size of six footsteps each, besides several others. Although this is inferior in dimensions to the latter, yet it is an incomparable specimen. For purity of impression it is unsurpassed, and the living reality of the rain-drops, the beautiful color of the stone, its sound texture and lightness, renders it a fit member for any collection of organic remains. Nor is the third slab of inferior interest.* It has two rows of the large foot of three and two impressions each, without blemish; one of the second size of two tracks, and two of the third with five and six footprints each. Besides it has a row of two impressions of an immense bird with a short broad foot, five inches by six, apparently palmated. It must have been as large as the African ostrich, for the stratum bent beneath its great weight and impressed that next below. The stride is twenty nine inches.

These magnificent specimens have been inspected by Prof. Hitchcock and by Prof. Silliman; to the former properly belongs the technical and complete description of them as his peculiar province. I therefore most willingly decline this difficult performance in respect to him, for to his successful labors, the subject of fossil footmarks owes its claims as an essential element of the science of organic geology.

Greenfield, Mass., Nov. 11, 1843.

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* Omitted in the plate.

Art. IX.—*A New Process for preparing Gallic Acid;* by Edward N. Kent.

TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

Gentlemen—During a recent examination of black ink, which had been prepared by exposure to the atmosphere for three months, I found it contained a quantity of free gallic acid, protosulphate of iron, and pertannate of iron.

Having previously experienced the inconvenience of waiting two months to prepare gallic acid by the old process, and as it is not an article of commerce, it occurred to me that if the acid in the ink could be easily isolated, it would form a valuable process for its preparation when wanted for immediate use, as ink can always be readily obtained containing the acid ready formed.

I therefore agitated a pint of ink with an equal measure of sulphuric ether,* left it at rest for a few moments to separate, and then decanted the ether, and found it had taken up gallic acid to the exclusion of the other constituents, except a light yellow color and odor of cloves, these having been put into the ink. I then distilled the ethereal solution nearly to dryness; the residue crystallized on cooling. I returned the distilled ether on the ink, and repeated the process the third time, and after crystallizing three times and drying, obtained twenty eight grains of colorless gallic acid.

I then distilled off from the ink a little remaining ether, and the ink was left as good for *ordinary* purposes as before; and the only expense in the preparation of the acid was the loss by evaporation of about one ounce of the ether.

Most of the inks which I have tried gave the same result when treated with ether. Some however which have been prepared by boiling the nutgalls, and exposure for a few days only, yielded principally tannic acid. It is therefore advisable to test the ink with gelatine before attempting to prepare gallic acid by this process. Yours, very respectfully,

Edward N. Kent.

New York, October 9th, 1843.

* I have repeated Mr. Kent's experiment successfully: care must be had that the ether is quite free from alcohol, which commercial ether never is. As gallic acid is more soluble in alcohol than in ether, the process is only partially successful when alcohol is present.—B. S. Jr.

ART. X.—*Solution to a Case in Sailing;* by W. CHAUVENET, A. M., Professor of Mathematics in the U. S. Naval School, Philadelphia.

IN a late treatise upon navigation, the following problem is solved by middle-latitude sailing, and the solution is accompanied with a note declaring that this case "cannot be solved by Mercator's sailing;"* and by referring to the various accessible works upon navigation I cannot find that any rigid solution has ever been printed, although it certainly cannot be regarded as difficult. The true solution may have been overlooked because it cannot be deduced by comparing the *similar triangles* employed in all popular works to illustrate Mercator's sailing; or it may have been neglected as unimportant because the case can seldom occur in practice. The problem however is not without interest, and a solution of it, theoretically accurate, though unnecessary to the advanced mathematician, may be acceptable to the student of navigation.

Problem.—"A ship sails in the N. W. quarter 248 miles (d) till her departure is 135 miles (p), and her difference of longitude 310 miles (D). Required her course (C), the latitude left and the latitude come to?"

Solution.—By putting l= proper difference of latitude, P= meridional difference of latitude, we have immediately from the data

$$l=\sqrt{d^2-p^2},\ \text{sin. C}=\frac{p}{d},\ \text{P=D cotang. C},\quad (1).$$

Now to find the two latitudes, represent them by $\text{L}+\frac{1}{2}l$ and $\text{L}-\frac{1}{2}l$, and let the meridional parts for these latitudes be A and A′. Then since an arc of Mercator's meridian from the equator to any latitude (the radius of the earth being 1) is equal to *the Naperian logarithm of the cotangent of half the co-latitude*, we have

$$\text{A}=\text{Nap. log. cotang. }\tfrac{1}{2}[90^\circ-(\text{L}+\tfrac{1}{2}l)]$$
$$\text{A}'=\text{Nap. log. cotang. }\tfrac{1}{2}[90^\circ-(\text{L}-\tfrac{1}{2}l)]$$

which reduced to nautical miles by multiplying by the radius $\text{R}=\frac{360\times 60}{2\pi}=3437.7$, and expressed in common logarithms by

* See Riddle's Navigation, (fourth edition,) pp. 177, 178.

dividing by the modulus M=.43429, become

$$A=7915.7 \text{ log. cotang. } \tfrac{1}{2}(90^\circ - L - \tfrac{1}{2}l)$$
$$A'=7915.7 \text{ log. cotang. } \tfrac{1}{2}(90^\circ - L + \tfrac{1}{2}l)$$

From these we obtain

$A-A'=P=7915.7$[log. cotang. $\frac{1}{2}(90^\circ - L - \frac{1}{2}l)$ − log. cotang. $\frac{1}{2}(90^\circ - L + \frac{1}{2}l)$]:

$$\frac{P}{7915.7} = \log. \frac{\text{cotang.}\frac{1}{2}(90^\circ - L - \frac{1}{2}l)}{\text{cotang.}\frac{1}{2}(90^\circ - L + \frac{1}{2}l)} = \log. \frac{\text{tang.}\frac{1}{2}(90^\circ - L + \frac{1}{2}l)}{\text{tang.}\frac{1}{2}(90^\circ - L - \frac{1}{2}l)};$$

and if $\frac{P}{7915.7} = \log. n$, we have

$$n = \frac{\text{tang.}\frac{1}{2}(90^\circ - L + \frac{1}{2}l)}{\text{tang.}\frac{1}{2}(90^\circ - L - \frac{1}{2}l)} = \frac{\cos.L + \sin.\frac{1}{2}l}{\cos.L - \sin.\frac{1}{2}l};$$

from which we find $\cos. L = \frac{n+1}{n-1} \sin.\frac{1}{2}l$, (2).

To facilitate the computation by logarithms, put $n = \text{cotang. } \varphi$, then $\frac{n+1}{n-1} = \text{tang.}(45^\circ + \varphi)$, and equation (2) becomes

$$\cos.L = \text{tang. } (45^\circ + \varphi) \sin.\tfrac{1}{2}l, \qquad (3),$$

which with the equation

$$\log. \text{cotang. } \varphi = \frac{P}{7915.7} = \frac{D \text{ cotang. } C}{7915.7}, \qquad (4)$$

furnishes a very easy solution to the question.

In the example proposed we find by equations (1), C=32° 59′, l=208′. The computation of equations (4) and (3) will be as follows:

C=32° 59′, . .	l. cotang. +0.18776
D=310, ...	+2.49136
Log. 7915.7, ...	−3.89849
Log. cotang. φ=0.06034, ...	8.78063
φ=41° 02′	
45°+φ=86° 02′, . . .	l. tang. 1.15900
$\frac{1}{2}l$=104′, . . .	l. sin. 8.48069
L=64° 08′, . . .	l. cos. 9.63969

L+$\frac{1}{2}l$=65° 52′, L−$\frac{1}{2}l$=62° 24′. The latitudes found by middle-latitude sailing, are 65° 55′, and 62° 27′.

U. S. Naval Asylum, Philadelphia, August, 1843.

ART. XI.—*A Monography of the North American species of the genus Equisetum*, by Prof. ALEXANDER BRAUN, of Carlsruhe, Germany; *translated from the author's manuscript, and with some additions*, by GEORGE ENGELMANN, M. D., of St. Louis, Missouri.

MY early friend and indefatigable correspondent, Prof. Alex. Braun, having placed in my hands a manuscript monography of the genus Equisetum, full of original views, and offering a very lucid exposition of this interesting genus, I believe I am rendering a service to the lovers of botany in this country by translating and publishing this paper; to which I add a few remarks of my own, chiefly relating to the two new species of the Western United States. G. E.

Before we come to the description of the different species, it will be necessary to explain the structure of the stems of the *Equiseta*, which afford much more characteristic distinctions than their fructification.

The *Equiseta* have simple or verticillately branched stems, which are all grooved (amongst the American species only *E. eburneum* makes an exception, as far as regards the stem, but not the branches); they have verticillate leaves, which are connected in sheaths; their points only being free, and forming what is called the teeth of the sheaths. The carinæ, or ridges of the stem, which separate the grooves (*valleculæ*) are either smooth, (*E. limosum*, *E. lævigatum*, etc.) or rough from siliceous tubercles, (*E. robustum*, *E. hyemale*, etc.): they are simple, (*E. limosum*, *E. robustum*,) or divided by a furrow (*sulcus*) along their back, so as to form two more or less distinct ridges (*E. hyemale*, *E. variegatum*, branches of *E. eburneum*). In one species (*E. scirpoides*,) the furrows dividing the carinæ become as large and deep as the grooves themselves, so that the apparent number of the carinæ is double that of the leaves.

In all the *Equiseta* with green stems, (but not in the discolored fertile ones of *E. arvense* and *E. eburneum*, or the white sterile ones of the latter,) the epidermis of the grooves or valleculæ is perforated by stomata. In the first division, these stomata are irregularly distributed over the surface of the grooves (therefore

EQUISETA SPEIROPORA); in the second division they are disposed regularly in two ranges on the sides of the grooves (E. STICHOPORA). These ranges consist either of one series or row of stomata each (as in all the northern species), or of two or more rows (as in many tropical ones). The stomata are only found in the grooves, never in the secondary furrows, even when these are of equal size and depth with the former.

The sheaths consist of united verticillate leaves, free only on the points, which constitute the *teeth;* and these teeth correspond in number and position with the carinæ of the stem; they are either persistent or deciduous. The leaves have either a single medial carina, or this carina is divided by a furrow, so as to appear double; or sometimes the margins of the leaves are elevated and form two lateral carinæ; thus the leaves may present from one to four carinæ. The furrow which sometimes divides the principal carina is the *carinal furrow;* and another which is frequently found on the connecting line or the commissure of two leaves is the *commissural furrow.*

The section of the stem exhibits the following structure. In the centre is a larger or smaller air-cavity or hollow space, *lacuna,* (wanting only in *E. scirpoides*); and around this a circle of generally much smaller air-cavities which correspond with the grooves or valleculæ, and which we therefore call *vallecular air cavities.* These are wanting in only one species, viz. *E. limosum.* Exterior to these again is a circle of alternating and still smaller air-cavities just under, or corresponding with the carinæ, (*carinal air-cavities,*) but they are sometimes very minute or nearly obliterated.

In some *Equiseta* there is no distinction of fertile and sterile stems: such are E. HOMOPHYADICA. Some of these have annual stems, (E. ÆSTIVALIA, *Summer-Equiseta,*) such as *E. palustre,* and *E. limosum:* others have perennial stems, not perishing in winter, (E. HYEMALIA, *Winter-Equiseta,*) such as *E. hyemale, E. scirpoides,* etc. In a second division, the fertile stems are different from the sterile ones; the latter only being herbaceous, branching and persistent through the season, while the fertile are discolored and simple: such are E. HETEROPHYADICA. In some of these the fertile stems are deciduous after fructification (E. VERNALIA, *Vernal Equiseta,*) as in *E. arvense* and *E. eburneum:* others, after fructification, produce verticillate herbaceous branch-

es, and become similar to the sterile ones and persistent through the season, (E. SUBVERNALIA, *Subvernal Equiseta*,) as is the case in *E. sylvaticum* and *E. pratense.*

EQUISETUM, *Linn.*

§1. EQUISETA SPEIROPORA: stomata irregularly dispersed over the whole surface of the grooves.

* *Heterophyadica*: fertile stems different from the sterile ones; the former early and discolored; the latter later and herbaceous.

† *Ametabola* (*Vernal Equiseta*): fertile stems simple, never herbaceous, deciduous before the full development of the sterile stems.

1. E. ARVENSE, *Linn.*—Sterile stems grooved, smoothish; sheaths consisting of about eleven 1-carinate leaves; carinæ with a very slight furrow on the back; the commissural furrows between them slight; carinæ of the simple branches compressed, rough; sheaths consisting of four 1-carinate leaves, with herbaceous ovate-acuminate subsquarrose teeth. Fertile stems simple; the sheaths consisting of 2-carinate leaves, which, at first connate up to the apex, finally separate into short teeth.

The sheaths of the fertile and sterile stems are composed (according to the size of the specimens) of from 7 to 15, but generally 10 to 13 leaves; the sheaths of the branches are mostly 4-, seldom 3- or 5-toothed. The summit of the sterile stem is attenuated, and like one of the branches.—We distinguish the following varieties.

β. NEMOROSUM, *A. Braun.* Large, 12 to 20 inches high; the branches with a few branchlets.—*E. pratense,* Roth and others, not Ehrh. In specimens from Missouri, the sheaths have 12 to 15 teeth; the fertile stems are 12 to 15, and the sterile ones 15 to 20 inches high: branches frequently 6 or 7 inches long.

γ. DECUMBENS, *Meyer, Chl. Hanov.* Sterile stems branching from the base, procumbent. In Missouri, sheaths with 7 to 8 teeth: stems 4 to 6 inches high; the lowest branches with a few branchlets.

δ. SEROTINUM, *Meyer, Chl. Hanov.* The usually sterile herbaceous stems also with fructification.—*E. campestre,* Schultz, prodr. fl. Starg.

Hab. Europe, Northern Asia, North America, from Greenland to the Northern States and Virginia, (*Pursh,*) to Kentucky, (*Short,*) Missouri, (*Engelmann, Riehl,*) the Rocky Mountains,

(*Fremont,*) and the North West coast, (*Chamisso.*) β. Germany, Kentucky, (*Short,*) Missouri, in fertile woods. γ. Germany, Missouri, in dry pastures, road sides. δ. Very rare, in Germany.

2. E. EBURNEUM, *Schreb.*—Sterile stems very smooth, ivory white; sheaths consisting of about thirty bicarinate leaves, separated by deep commissural furrows; carinæ of the simple branches again deeply furrowed, scabrous; their sheaths consisting of four (sometimes five) bicarinate leaves, with herbaceous erect subulate fragile teeth. Fertile stems simple, sheaths consisting of obsoletely 3-carinate leaves, with lanceolate subulate teeth.—*E. Telmateja*, Ehrh. *E. fluviatile*, Smith, Willd., Vaucher, not Hoffm. *E. decumanum*, Pallas, (Siberia,) *E. macrostachyon*, Poir. (Barbary.)

β. FRONDESCENS. Fertile stems persistent, producing herbaceous branchlets.

γ. SEROTINUM. The usually sterile stems with late fructification.

Hab. Europe, Asia, North Africa and North America, (on Lakes Erie and Superior, *Torrey*, according to Beck's Botany.)

The sheaths of the fertile and sterile stems are formed by from 20 to 40 leaves, generally 24 to 36. Sterile stems from 2 to 5 feet high.

†† *Metabola*, (*Subvernal Equiseta*): fertile stems persistent and producing herbaceous branches after fructification.

3. E. SYLVATICUM, *Linn.*—Sterile (and finally also the fertile) stems doubly branched, the branchlets curved downwards; stems grooved, fertile ones nearly smooth; carinæ of the sterile ones scabrous, in two rows; sheaths consisting of about twelve 1-carinate leaves with shallow commissural furrows between them; their scarious elongated points partly connate, so that the sheaths appear to be 3- or 4-lobed; carinæ of the branches slightly furrowed, somewhat scabrous; carinæ of the branchlets compressed, smooth, their sheaths funnel-shaped, consisting of 4 or 5 (on the branches) and 3 (on the branchlets,) 1-carinate leaves with lanceolate-acuminate divergent teeth.

Hab. Europe, Asia, North America, from Labrador (*Unger,*) to Massachusetts, (*Oakes,*) Pennsylvania, (*Muhlenberg,*) Virginia, (*Pursh,*) and Ohio, (*Riehl.*)

The sheaths of the stem are formed by 8 to 17 (generally 10 to 14) leaves whose points are connected in 2 to 4 or more lobes,

which, before the development of branches, distinguish the fertile stem from *E. arvense*. *E. sylvaticum* as well as *E. arvense* have tubers on the creeping rhizoma, which Prof. Braun could not find in *E. eburneum;* the other species have certainly none.

4. E. PRATENSE, *Ehrh.*—Sterile (and finally also the fertile) stems with simple straight branches, both grooved; carinæ scabrous, in one row; sheaths consisting of about 11 leaves, with very shallow carinal and deeper commissural furrows, teeth scarious, ovate-lanceolate, and all free; carinæ of the branches slightly scabrous, much compressed; urceolate sheaths consisting of three 1-carinate leaves with herbaceous erect very short and somewhat obtuse teeth.—*E. umbrosum*, Meyer, in Willd. *E. Ehrharti*, Meyer, Chl. Hanov. *E. amphibolum*, Retz. *E. triquetrum*, Bory. *E. Drummondii*, Hook.

Hab. This species appears to inhabit extensively the northern countries of Europe and Asia; it is rare in Scotland, common in Scandinavia, in the North of Germany, in Russia and Siberia; also in the Alps and Pyrenees; in Arctic America and Greenland according to Sprengel. It is easily distinguished from the foregoing, much more common, species by the shorter, never connate teeth of the sheaths of the stem, the 3-teethed sheaths of the branches, and the absence of branchlets.

** *Homophyadica*, (*Summer Equiseta*): fertile and sterile stems similar, both herbaceous and contemporaneous; or all the stems fertile. (All the known species belonging to this section have annual stems, not persistent in winter.)

5. E. PALUSTRE, *Linn.*—Stems generally with simple verticillate branches, deeply grooved, somewhat scabrous; vallecular air cavities large, the carinal ones very small; sheaths loose, consisting of about 8 leaves separated by shallow commissural furrows and above with carinal ones; teeth lanceolate, acute, dark ferruginous, with broad membranaceous margins; branches smilar to the stem, with acuminate adpressed somewhat sphacelate teeth of the mostly 5-leaved sheaths. *E. pratense*, Reichenb., not Ehrh. nor Roth.

β. SIMPLICISSIMUM. Stems without branches.

γ. POLYSTACHYUM. Branches elongated, bearing heads.

Hab. Europe, North America, Arctic America to Virginia, (*Beck's Botany.*)—Sheaths of the stem with 6 to 10, mostly 7 to 9 teeth. A very polymorphous species. Nearly related to this

species is *E. Bogotense*, Humb., Bonpl. and Kunth. (Syn. *E. stipulaceum*, Vaucher, and *E. flagelliferum*, Kunze.)

6. E. LIMOSUM, *Linn.*—Stems tall, erect, generally above with simple branches, the sterile ones much elongated; grooved, nearly smooth; vallecular air-cavities none, the carinal ones small, the central cavity very large; sheaths adpressed, consisting of about eighteen 1-carinate not furrowed leaves, with linear acute blackish teeth nearly destitute of a membranaceous margin; branches somewhat scabrous; sheaths herbaceous, consisting of about six leaves with linear-setaceous points.—*E. limosum* and *E. fluviatile*, Hoffm. and other authors. *E. Heleocharis*, Ehrh.

β. MINUS, *A. Braun.* Stems simple, somewhat scabrous, sheaths consisting of about eleven leaves.—*E. uliginosum*, Muhlenb., Willd.

γ. POLYSTACHYUM. With numerous short verticillate, floriferous branches.

Hab. In ditches and swamps in Europe. In the United States in Pennsylvania, (*Wolle,*) New York, (*H. Eaton,*) and Wisconsin, (*Lapham in herb. Short.*) β. in North America, Newfoundland, (*La Pylaie,*) Northern States, (*Beck's Botany,*) Pennsylvania, (*Muhlenberg,*) Virginia, (*Pursh.*) Also in Germany in peat morasses, (*A. Braun.*) Easily distinguished from *E. palustre*, by the structure of the stem and by the teeth; though at first sight var. β. considerably resembles some forms of the former. The sheaths are composed of 10 to 22 leaves, commonly 17 to 20, in the American specimens examined by me of 15 to 21, in β. of 10 to 12 leaves. Rhizoma never tuberous. The branches are generally developed after fructification.

§ 2. EQUISETA STICHOPORA, (*Winter-Equiseta*): Stomata disposed in two distinct ranges on each side of the groove; each range formed by one or more rows of stomata. (All the known species of this division, have hardy evergreen stems.)

Most of the tropical Equiseta, as well also as some of the most northern species, (*E. scirpoides* and *E. boreale,*) belong to this large and very difficult division. They all contain more silex beneath the cuticle than the *E. speiropora*, which accounts for their hardness and durability. Their distinguishing characteristic is the disposition of the stomata in two ranges, separated by a free interstice. In the European and North American species,

these ranges consist of a single row of stomata; in many tropical species each range has two or more rows. The spikes are mostly acute.

* *Heterophyadica.* (It is questionable whether any species exists belonging to this section. *E. myriochæton*, Schlecht. and Cham. from Mexico, so far known only from sterile specimens, might possibly prove to have different and earlier fertile stems.)

** *Homophyadica.*

† Ranges of stomata consisting each of one row.

7. E. LÆVIGATUM, *A. Braun.*—Stems tall, erect, simple or somewhat branching; carinæ convex, obtuse, smooth; grooves shallow on each side, with a single series of stomata; vallecular air-cavities small, the carinal ones very minute; central cavity large; sheaths elongated, adpressed, with a black limb, consisting of about twenty two leaves with one carina at base and (by the elevation of the margins and depressions of the middle) two towards the point; points linear-subulate, sphacelate, caducous, leaving a truncate-dentate margin to the sheath; branches somewhat rough; sheaths with about eight indistinctly 3-carinate leaves; points persistent, subulate, sphacelate with a narrow membranaceous margin.

β. SCABRELLUM, *Engelm.*—Carinæ more elevated, somewhat rough with small tubercles; leaves above with two rather rough lateral carinæ, convex in the middle; teeth subulate, black at the base, membranaceous on the margin and towards the point, mostly persistent.

γ. ELATUM, *Engelm.*—Very tall; sheaths with about thirty leaves, the points linear-lanceolate, membranaceous, irregularly deciduous, leaving a ragged truncate-dentate black margin.

Hab. On poor clayey soil, with Andropogon and other coarse grasses, at the foot of the rocky Mississippi hills, on the banks of the river, below St. Louis, (*N. Riehl,*) who discovered it 1840, (*G. Engelmann*) α. and β. γ. Near Newbern, North Carolina, (*Loomis & Croom in herb. Short.*) Mr. Curtis informs me that this is probably the only species in that section.

In size and manner of growth this new species is closely allied to *E. hyemale*, and the larger variety to *E. robustum;* but it is easily distinguished by its smoothness, its long green sheaths, with a narrow black limb, and its darker green color; in some of these respects it approaches to *E. limosum*, but differs by the deciduous teeth, the regularly disposed stomata, the structure of the stem, etc. It is generally one and a half to two, and even three feet

high; but var. γ. attains, according to the label in Prof. Short's herbarium, a height of four feet and a half. The stems are simple, or occasionally branched, with 20 to 24 carinæ, but I have collected specimens with from 18 to 27 carinæ. Generally they are perfectly smooth, but younger specimens and sometimes older ones also are somewhat rough, with rather persistent teeth, approaching the small variety of the next species, but they can always be distinguished from that by the sheaths being nearly twice as long, rarely with a black girdle at the base, more green, and by the medial carinæ of the leaves not extending to the point. (In the small variety of *E. robustum*, it is strongly marked and very rough.) The young sterile shoots with about 15 to 17 carinæ are also more rough than the fertile stems, and resemble in that respect the branches, which have 7 to 10 leaves with persistent points. The sheaths, as has been stated, have generally only a narrow black limb, but some specimens have also, especially on the lower sheaths, a black girdle at base; in one specimen I have seen the whole sheath black. The spikes are generally more obtuse than in *E. hyemale*. The var. γ. has much the appearance of *E. robustum*, and it is equally large and stout, but is very distinct in all other respects. From the very fragmentary specimens seen by me, it seems impossible to distinguish it specifically from the Missouri plant.

8. E. ROBUSTUM, *A. Braun.*—Stems very tall and stout, erect, simple or slightly branching above; carinæ narrow, rough with one line of tubercles; grooves shallow, on each side with a single series of stomata; vallecular air-cavities large, the carinal ones nearly none; central cavity very large; sheaths short, adpressed, with a black girdle above the base, rarely with a black limb, consisting of about forty (in the branches eleven) leaves, 3-carinate from the black girdle to the limb; the points ovate-subulate, sphacelate, deciduous, leaving an exactly truncate margin. *E. procerum*, Bory ined., non Pollini. *E. prælatum*, Raf.?

β. MINUS, *Engelm.* Fertile stems with 28 to 31 carinæ, 2 to 3 feet high; points of the leaves more persistent.

γ. AFFINE, *Engelm.* Fertile stems simple, with 20 to 25 carinæ, 1 to 2 feet high; teeth subulate-aristate, mostly persistent, black, rough, finally becoming white.

Hab. Islands of the Mississippi in Louisiana, (*Bory de St. Vincent.*) Banks of Red River, (*Dr. Hale, in herb. Short.*) Banks

of the Wabash and Ohio, and the Mississippi near St. Louis, also on lakes and smaller streams in that region, (*G. Engelmann.*) Banks of the Missouri up to Eau-qui-coule River, (*Geyer in Nicollet's Expedition.*) Also in the East Indies; Lahore, (*Jacquemont,*) Pondicherry, (*Belanger.*) Varieties β. and γ. near St. Louis, the first with the common form, the other with *E. lævigatum*, on poorer soil.

This stately species appears to take the place of *E. hyemale* in the Mississippi valley, at least in its middle and southern parts. It reaches a size of from three or four to even six feet, (*Geyer.*) The largest specimens from Louisiana, have 44 to 48, those from the Ohio and from St. Louis, have all from 37 to 41 carinæ, and consequently leaves. The species is distinguished from *E. hyemale* by its size, by the strictly simple row of tubercles on the ridges, and by the 3-carinate (not 4-carinate) leaves. It is a remarkable peculiarity that in old specimens, not only the teeth or points are deciduous, but also the upper part of the sheath itself down to the black girdle, giving the stems the appearance of the fossil *Calamites*, with reduced dimensions. The branches of flowering stems have usually 11 carinæ, but branches of old decaying stems, and young sterile shoots have 17 to 25 and more carinæ.

Var. β. offers no difficulties; but γ. approaches very closely, rather too much so, to the next species, whence the name. It has the same size and growth, but the sheaths appear to be shorter, their leaves never 4-carinate, and the tubercles on the carinæ of the stem constantly in one row. This variety corresponds with var. γ. of the next species, both being much smaller than the common forms, and much rougher also; the roughness extending to the points of the leaves and rendering them more persistent.

9. E. HYEMALE, *Linn.*—Stems tall, erect, simple, rarely with a few branches; carinæ rough with two more or less distinct rows of tubercles; grooves on each side with a single series of stomata; vallecular air-cavities large, the carinal ones minute; central cavity large; sheaths elongated, closely adpressed, with a black girdle above the base, and a black limb, consisting of about 20 (in the branches 9) narrowly linear, at base 1-carinate, above obsoletely 4-carinate leaves, with linear-subulate deciduous points, which leave a bluntly crenate margin.

β. PALEACEUM, *A. Braun.*—Stems smaller, sheaths with a black limb, but mostly without a black girdle, consisting of 10 to 12

evidently 4-carinate leaves; their points less deciduous, sphacelate, nearly smooth.—*E. paleaceum*, Schleicher.

γ. TRACHYODON, *A. Braun.*—Stem smaller; carinæ more plainly with two rows of tubercles, which are separated by a furrow; sheaths with a black limb, consisting of about ten evidently 4-carinate leaves, their points less deciduous, whitish or sphacelate, rough on the back.

Hab. Europe, with all the varieties; in North America, only the common form has yet been remarked: Pennsylvania, (*Muhlenberg, Schweinitz,*) Canada and Northern States, (*Beck's Botany, &c.,*) Michigan, (*Engelmann,*) to Kentucky, (*Short.*) Both varieties will doubtless be found in this country.

Specimens from the sandy shores of Manitou Island, Lake Michigan, have in the fertile stems 24 to 26 carinæ, (in the smaller sterile ones 17,) with nearly one row of tubercles; the black limb of the sheath is somewhat indistinct; leaves with 4 or sometimes (by obliteration of the carinal furrow) only 3 carinæ; teeth white, less deciduous, leaving a more exactly truncate margin. Specimens from Kentucky have 20 to 28 carinæ; tubercles nearly in one row; leaves with 4 or only 3 carinæ; very near *E. robustum, γ. affine!* Var. γ. is by far the roughest form; by its smaller size, and plainly 2-rowed tubercles on the carinæ, it approaches to *E. variegatum*. *E. hyemale* is a northern plant, being replaced towards the south in North America, by the larger *E. robustum*, and in Europe by a smaller species, the much-confounded *E. elongatum*, Willd., (*E. ramosum*, Schleich., *E. pannonicum*, Kit., *E. Illyricum*, Hoppe, etc.,) which extends from Southern Germany, through the whole of Southern Europe to Northern Africa, Arabia, and middle Asia, and a variety of which occurs again at the Cape of Good Hope, Isle of Bourbon, and Isle of France: but it has not yet been met with in America.

10? E. BOREALE, *Bongard.*—Found in Sitcha on the Northwest coast by Dr. Mertens, is unknown to me; perhaps a variety of *E. hyemale?* (*A. Braun.*)

11. E. VARIEGATUM, *Schleicher.*—Cæspitose; stems low, simple; carinæ rough with two rows of tubercles, separated by a furrow; the grooves larger and deeper than the furrows, on each side with a single series of stomata; vallecular air-cavities of the same width as the central cavity, the carinal ones very small; sheaths somewhat campanulate, variegated with black, consisting of about

seven 4-carinate leaves; the points persistent, ovate membranaceous, with fragile awns.

β. REPTANS, *A. Braun.*—Stems small, procumbent at base, sheaths consisting of about four leaves.—*E. reptans*, Wahlenb. in part. Wahlenberg comprises this variety and the following species in his *E. reptans.*

Hab. Northern Europe; also on the Alps in Central Europe, and along the rivers rising in them. Also in North America, Niagara, (*Dr. Kinnicutt*, according to *Torrey;*) Vermont, (*J. Carey*, according to *Oakes.*) In Prof. Short's herbarium, I have seen a specimen from New York, which I cannot but refer here, though the central cavity is much larger than the vallecular ones, and the 8 carinæ of the stems are nearly simple. In German specimens the sheaths have 6 to 8, rarely 9 to 10 leaves; var. *β.* growing only in higher latitudes, has four or five, very rarely only three teeth.

12. E. SCIRPOIDES, *Michx.*—Cæspitose; stems low, filiform, somewhat flexuous, simple; rough on the angles which are formed by the equally wide grooves between, and furrows on the carinæ; on each side of the grooves a single series of stomata; vallecular air-cavities large, no carinal ones, no central cavity; sheaths somewhat turbinate, variegated with black, consisting of three, rarely four, 4-carinate leaves; the points persistent, ovate, cuspidate, membranaceous, whitish.

Hab. Arctic America, (*Beck's Botany,*) Newfoundland, (*Herb. Willd.,*) Canada, (*Michx.,*) Northern States, (*Carey, Oakes,* and others.) Lately discovered also in Arctic Europe.

This is the smallest of all the known species, with very rarely more than three teeth in the sheaths, but always double the number of angles on the stem. Three of the grooves between these angles correspond with the leaves and are without stomata; the three alternating ones correspond with the commissure of the leaves, and have each two ranges of stomata.

†† Ranges of stomata consisting each of two or more rows.

E. GIGANTEUM, *Linn.* and others, of South America, belongs here. Several species undoubtedly have been confounded under this name, which are all nearly related to *E. robustum*, but are well distinguished by having two or three rows of stomata in each range. No North American or European species, so far as known, belongs to this section.

ART. XII.—*A Brief Notice of the Charæ of North America;* by Prof. ALEXANDER BRAUN,—communicated by Dr. ENGELMANN.

BESIDES the Equiseta, Prof. Braun has devoted much attention to other families of Cryptogamous plants, such as the *Rhizocarpeæ;* of which he has lately published two new North American species of *Marsilea:* viz. *M. uncinata*, found in 1835 by the writer of this note in Arkansas; and *M. mucronata*, discovered in the year 1839 by Mr. Geyer, in Nicollet's Northwestern Expedition, along the saline prairies near Devil's Lake. Both are nearly related to *M. vestita*, Hook. & Arn. of Oregon, but very different from the European *M. quadrifolia*. But Prof. Braun's especial favorites are the *Charæ*, which he has very thoroughly investigated, and intends soon to describe monographically. As these obscure plants are seldom collected by our botanists, he has not enjoyed so good opportunities of studying American specimens as could be wished. He therefore urgently requests American botanists to aid him by the communication of their collections in this genus, (either in the way of loan or exchange,) in order that the species of this country may be more satisfactorily elucidated.* The subjoined list comprises eleven North American species, which have fallen under his notice in various European herbaria. Five of these are identical with European species; four are distinct, but nearly related forms; while two belong to a section which has no known representative in Europe. G. E.

Charæ of North America.

A. CHARÆ EPIGYNÆ, *A. Braun.* (Nitella, *Agardh*, partly.)

1. CH. FLEXILIS, *Linn.* (vera?)—Sterile specimens, Pennsylvania? *Schweinitz in herb. Zeyher.* In the Merrimac, Massachusetts, *Greene.*

2. CH. GLOMERULIFOLIA, *A. Braun.*—(Subspecies of *C. flexilis.*) In the Merrimac, *Greene.*

3. CH. MUCRONATA, *A. Braun.*—(*C. flexilis* of authors, partly) var. Americana? A. Braun. In the Merrimac, *Greene.*

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* Dr. Engelmann of St. Louis, and also Prof. Gray of Harvard University, will cheerfully take charge of parcels or communications addressed to Prof. Braun.

4. Ch. capitellata, *Elliott.*—Georgia, *Le Conte*, in different herbaria. Called *C. tenella* by Braun, before he was aware of Elliott's name. Where has Elliott described it?

5. Ch. tenuissima, *Desv.*—Not to be distinguished from European specimens. Boston, *Greene, in herb. Decaisne.*

B. Charæ hypogynæ, *A. Braun.*

6. Ch. Schweinitzii, *A. Braun.*—Subspecies of *Ch. coronata*, and very near *Ch. Braunii.*

α. longibracteata. = *Ch. foliolosa*, Schwein. (non Muhlenb.)

β. brevibracteata, condensata. = *Ch. foliolosa*, Un. Itin.

γ. brevibracteata, laxa. = *Ch. opaca*, Schwein. (non Agardh.)

Pennsylvania and Georgia, in many herbaria. This species appears to be generally mistaken in the United States for *Ch. foliolosa*, Muhl.; but in Willdenow's herbarium an entirely different plant, sent by Muhlenberg, is preserved under this name.

7. Ch. vulgaris, *Auct.*—Pennsylvania, Georgia, etc. in different varieties.

8. Ch. aspera, *Willd.*—Newfoundland, *La Pylaie.*

9. Ch. fragilis, *Desv.*—Newfoundland, *La Pylaie;* Pennsylvania? (*Schweinitz*, under his *Ch. opaca;* Georgia? (*Le Conte in herb. Zeyher*, mixed with *Chara vulgaris*, *Najas flexilis*, and the undescribed *Zanichellia cochlospermum*, A. Braun.

10. Ch. foliolosa, *Muhlenb. in Willd.*, can hardly be distinguished from the East Indian *Ch. Zeylanica*, belonging to the quite distinct group of *Gymnopodæ*, A. Braun.

11. Ch. Michauxii, *A. Braun.*—Ohio, *Michx.* and *Dr. Frank.* This belongs to the same group as the foregoing, and must be ranged together with it as subspecies, under the principal species *Ch. polyphylla*, A. Braun.

ART. XIII.—*Catalogue of a collection of Plants made in Illinois and Missouri, by Charles A. Geyer; with critical remarks, &c.* by GEORGE ENGELMANN, M. D., of St. Louis.

MR. GEYER, who is an excellent collector, is now absent on an expedition to the Rocky Mountains and Oregon, as announced in the last volume of this Journal, (p. 226.) Being unwilling to adopt the common plan of selling his collections to subscribers before they are actually made, he prefers to seek some needful aid in the prosecution of his arduous undertaking, by offering to the botanical public sets of the following plants, collected in 1842 near St. Louis, Missouri, and around Beardstown on the Illinois River. This collection (which is duly mentioned on p. 227 of Vol. XLV,) consists of the following species.

1. Ranunculus micranthus, Nutt. Apparently common in the grassy river bottoms, and on fertile grassy hills in Missouri and Illinois. It is very near *R. abortivus*, but apparently well distinguished by its pubescence, and the more orbicular, very seldom cordate or reniform lowest leaves.

2. Ranunculus fascicularis, Muhl.

3. Myosurus minimus, Linn. Certainly a native plant.*

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* We now ought to be careful observers of such plants as are apparently common to both continents: in after years it will be much more difficult to decide which are natives and which introduced. Many European plants, now common weeds east of the Alleghany Mountains, have not yet found their way to the Mississippi valley, but undoubtedly will arrive in a short time. Other plants are here already as common as they are in Europe, from whence they were derived, or in middle Asia, perhaps their original home. It behooves us therefore to note the progress of these intruders, and distinguish from them the true natives.

We are able to distinguish several different classes of such plants:

1. *Nearly allied geographical species*, where one takes the place of the other in the other continent; such as *Quercus alba* in North America, and *Q. pedunculata* in Europe; *Carpinus Americana* and *C. Betulus*; *Polygonum Persoonii* (n. sp. *P. mite*, Pers.) and *P. mite*, Schrank; *Androsace occidentalis* and *A. elongata*; *Lycopus sinuatus* and *L. Europæus*, and many others.

2. *Geographical varieties*, where no specific distinction can be discovered between the natives of both continents, but where the American and European variety can always be distinguished by some points of minor importance. Such are *Sium latifolium*, *Circæa lutetiana*, *Samolus Valerandi*, (if it does not belong to the first class.) *Castanea vesca*, *Lepidium ruderale*, *Astragalus hypoglottis*, *Eriophorum gracile*, *Myosurus minimus*, etc.

3. *Identical plants*, true natives of both continents, especially arctic or at least northern plants; also marine species and cryptogamic plants; e. g. *Potentilla an-*

4. Isopyrum biternatum, Torr. & Gr.

5. Delphinium tricorne, Michx.

6. Trautvetteria palmata, Fisch and Mey.; an entirely new locality for this rare plant, which has heretofore only been found in the Alleghany and Rocky Mountains.

7. Thalictrum anemonoides, Michx.

8. Brasenia peltata, Pursh.

9. Corydalis aurea, Willd.; the smaller, glaucous variety of the banks of the western rivers.

10. Cardamine Ludoviciana, Hook.
11. Cardamine hirsuta, Linn. δ. Virginica.
12. Sisymbrium canescens, Nutt.
13. Draba brachycarpa, Nutt.
14. Draba Caroliniana, Walt.
15. Lepidium Virginicum, Linn.
16. Polygala purpurea, Nutt.
17. Polygala incarnata, Linn.
18. Polygala verticillata, Linn.
19. Viola pedata, Linn.

20. Viola delphinifolia, Nutt.; common in rich prairie soil in Illinois and Missouri, where it does not take the place of *V. pedata*, as Nuttall intimates, but grows in the same region, though never on such poor clayey or gravelly soil as *V. pedata*.

21. Viola palmata, Linn., and

22. Viola sororia, Willd, are certainly nothing but varieties of *V. cucullata*, Ait.

23. Viola sagittata, Ait.
24. Viola striata, Ait.
25. Parnassia Caroliniana, Michx.
26. Hypericum sphærocarpum, Michx.
27. Hypericum Sarothra, Michx.

28. Anychia capillacea, Nutt.; well distinguished from *A. dichotoma*, Michx. by the smooth stem, the ovate or oblanceolate obtuse leaves of the branches, the pedunculate flowers, 1-nerved obtuse sepals, and twice as large seeds.

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serina, *Campanula rotundifolia*, *Epilobium spicatum*, *Cornus Succica*, *Phragmites communis*, *Salicornia herbacea*, *Glaux maritima*, most *Equiseta*, etc.

4. *Naturalized plants*, spreading with the progress of civilization: of these we have in the neighborhood of St. Louis, *Taraxacum Dens-Leonis*, *Marrubium vulgare*, *Trifolium repens*, *Bromus secalinus*, *Verbascum Thapsus* and *V. Blattaria*, (perhaps belonging to the third class,) *Nepeta Cataria*, *Arctium minus*, etc. *Cichorium Intybus*, *Echium vulgare*, and others, I have not seen in the west.

It is difficult to decide to which of these classes *Datura Stramonium* and *Portulacca oleracea* should be referred. *Datura* is perhaps introduced in Europe as well as America, and possibly did not reach this country from Europe. *Erigeron Canadense* and *Œnothera biennis* are now as widely naturalized in Europe, as *Taraxacum* is in America.

29. Linum rigidum, Pursh.

30. Malva Houghtonii, Torr. & Gr. Intermediate between *Malva* and *Sphæralcea;* the carpels being 1-seeded as in Malva, but 2-valved as in Sphæralcea. The carpels separate mostly from the receptacle and from one another before opening.

31. Psoralea floribunda, Nutt.

32. Amorpha canescens, Nutt.

33. Petalostemon violaceum, Michx.

34. Astragalus trichocalyx, Nutt.? Probably a different species, but as I am unable to compare original specimens of Nuttall's plant, I am at present unable to decide. This species grows from a very strong fusiform ligneous root, in many cespitose stems, in the rich prairies and on grassy hills near St. Louis, (in Illinois,) and through the whole state of Missouri. It flowers in April and in beginning of May. The corolla is ochroleucous, with a bluish tip to the carina; the unripe legumes are succulent and edible, and when boiled resembling young beans in taste.

35. Desmodium sessilifolium, Torr. & Gr.

36. Lespedeza capitata, Michx.

37. Crotalaria sagittalis, Linn.

38. Spiræa lobata, Murr., and

39. Sanguisorba Canadensis, Linn. New localities for these plants, and probably the southern limit for them in the Mississippi valley.

40. Cratægus coccinea, Linn. var.? mollis, Torr. & Gr.

41. Cratægus tomentosa, Linn.

42. Rhexia Virginica, Linn.

43. Callitriche vernalis, Kützing, (in Linnæa, VII, 178.) One of the species of this genus common to America and Europe, and by most authors confounded with several others under the name of *C. verna*, Linn. It is well distinguished by the four angles of the small fruit being carinate; most other species having broadly winged angles and larger fruits.

44. Cicuta maculata, Linn.

45. Thaspium cordatum, Torr. & Gr.

46. Galium pilosum, Ait.

47. Spermacoce glabra, Michx.

48. Diodia teres, Walt.

49. Hedyotis minima, Torr. & Gr.

50. Hedyotis purpurea, var. Torr. & Gr.

51. Liatris cylindracea, Michx.

52. Liatris pycnostachya, Michx.

53. Aster sericeus, Vent.

54. Aster turbinellus, Lindl.

55. Aster azureus, Lindl.

56. Aster sagittifolius, Willd.

57. Aster multiflorus, Ait.
58. Aster dumosus, Linn.?
59. Aster miser, Linn.
γ. diffusus, Torr. & Gr.
60. Aster simplex, Willd.
61. Aster carneus, Nees.
62. Aster puniceus, Linn.
β. firmus, Nees.
63. Aster oblongifolius, Nutt.
64. Diplopappus linariifolius, Hook.
65. Diplopappus umbellatus, Torr. & Gr.
66. Solidago speciosa, Nutt.
67. Chrysopsis villosa, Nutt.
68. Silphium integrifolium, Michx.
69. Echinacea angustifolia, DC.
70. Helianthus occidentalis, Ridd.
71. Helianthus doronicoides, Lam.
72. Helianthus hirsutus, Raf.
73. Artemisia caudata, Michx.

73 *b*. Matricaria discoidea, DC. I have no doubt of this plant being a native here, and not introduced from Oregon or California, as Torrey and Gray (Flora, II, 413) suggest. It grows not only on wastes and roadsides near and even in St. Louis—(here it is found with *Maruta Cotula*, but flowers before this is six inches above ground)—but also four or five miles from the town, on grassy spots in the woods.

74. Hieracium Gronovii, Linn.
75. Lobelia leptostachya, A. DC.
76. Campanula aparinoides, Pursh.
77. Specularia perfoliata, A. DC.
78. Asclepias verticillata, Linn.
79. Asclepias incarnata, Linn.
80. Gentiana rubricaulis, Keat.
81. Gentiana ochroleuca, Willd.
82. Phlox glaberrima, Linn.

83. Cuscuta vulgivaga, Engelm. in Sill. Journ. XLIII, 338. C. Gronovii, Choisy. C. Americana, Auctor.

84. Cuscuta Cephalanthi, Engelm. Well distinguished by its small cylindric flowers, and by the corolla remaining on top of the capsule. It is found more on *Vernonia fasciculata* than on *Cephalanthus*. So far only found near St. Louis.

85. Lepidanche Compositarum, Engelm. So far only found in the prairies of Indiana, Illinois and Missouri. Cuscuta glomerata, Choisy.

86. Myosotis verna, Nutt.? If the description of *Myosotis verna* given in some American floras is correct, our plant cannot be the true *verna*. But as I have neither seen Nuttall's character, nor original specimens, nor eastern specimens at all, I must leave

this undecided. If our plant should prove distinct, I would suggest the name *M. inflexa*, adopted by me long since. I add the distinguishing characters of the European, the Western, and a nearly related Texan species.

Myosotis stricta (Link): calycibus profunde 5-fidis, laciniis subæqualibus linearibus obtusiusculis; calyce fructifero clauso; racemis basi foliatis; pedicellis fructiferis calyce brevioribus; tubo corollæ incluso; nucibus minimis.—*M. arvensis*, Reichenb., non Link, Lehm., Ehrh.

Europe.—Nuts grayish olive, very small, equal in size to the black nuts of *M. versicolor*.

M. inflexa (n. sp.): calycibus 5-fidis, laciniis calycis fructiferi erecto-conniventibus inæqualibus 2 inferioribus longioribus omnibus lanceolatis acutis albo-hispidis; racemis basi foliatis; pedicellis fructiferis calyce subbrevioribus basi erectis adpressis medio inflexis horizontalibus; tubo corollæ incluso; nucibus mediis *M. verna*, Nutt.?

Missouri and Illinois, dry prairies, open woods. April and May.—Annual or biennial? Calyx bilabiate; nuts twice as large as in the foregoing, of same color, equal in size to the black nuts of *M. intermedia*, Link.

M. macrosperma (n. sp.): calycibus 5-fidis, laciniis calycis fructiferi ovatis triangularibus acutis 2 inferioribus 3 superiores duplo superantibus, omnibus erecto-conniventibus flavo- s. ferrugineo-hispidissimis; racemis basi subfoliatis; pedicellis fructiferis calyce brevioribus basi adpressis; calycibus horizontalibus; tubo corollæ denique calyce longiore; nucibus maximis.

Texas, prairies, April. *F. Lindheimer.*—Nuts of same color as both others, but twice as large as those of the last, and larger than those of any European species examined by me; uncinate hairs of the calyx very long, stiff, spreading in all directions; flowers not so crowded as in both the foregoing species.

87. Phacelia Purshii, Buckley, in Sill. Journ. XLV, 171.

88. Physalis Pennsylvanica, Linn. Some of the specimens have smooth, and others pubescent or hairy calyces; these last ones constitute the *P. lanceolata*, Michx.

89. Pentstemon pubescens, Linn.
90. Collinsia verna, Nutt.
91. Gratiola aurea, Muhl.?
92. Hedeoma pulegioides, Pers.
93. Hedeoma hispida, Pursh.
94. Pycnanthemum pilosum. Nutt.

95. Monarda punctata, Linn.

96. Dracocephalon Virginianum, Linn.

97. Scutellaria galericulata, Linn.

98. Verbena paniculata, Lam. With undivided leaves, the true *V. paniculata;* and with the lower leaves divided, lobed or hastate, *V. hastata*, Linn., which can hardly be called even a variety. As Lamarck's name is equally applicable to both forms, it probably ought to be preferred to the Linnæan name.

99 to 102. Four hybrids of different species of Verbena, which together with several others that abound in this neighborhood, Mr. Geyer appears to have found equally abundant on the sandy wastes near Beardstown, and on the sandy islands of the Illinois River.

The names, chosen according to Schiede's proposition, indicate the parent plants; but it is often difficult enough to detect the parentage; indeed to ascertain which is the male and which the female parent is probably quite impossible if actual experiments be not instituted. Generally both parents grow near the hybrid, but as these Verbenæ are perennial, the hybrids, being unable to produce seed, propagate the more readily by stolons, and spread in some localities so as even to exceed one or the other of the parents in number. In such cases we have to rely entirely on the resemblance of the offspring to some true species in the vicinity. All these hybrids, however, are known to be such by their luxuriant growth exceeding that of their parents, by their sterility, and mostly by their local appearance in places where their parents are common. We find, as is naturally to be expected, many hybrids which resemble one of their parents more than the other; and hence many intermediate hybrid forms may be observed, so as to furnish all the connecting links between two very distinct species; this of course not proving the identity of such species, but rather the reverse. No hybrids are more common here than those between *V. stricta*, Vent. and *V. urticæfolia*, Linn., and I possess specimens not only of *V. urticæfolio-stricta*, (near *V. stricta*,) and of *V. stricto-urticæfolia*, (near *V. urticæfolia*,) but of several intermediate forms; the extremes of which might be taken for mere varieties of *V. stricta* and of *V. urticæfolia;* or they may be produced by seeds from these plants, adulterated by some pollen from the other species. The difficulty is increased by the fact that these doubtful hybrids produce more

seeds than the nearly intermediate hybrids, though far less than the true species. In the course of time, if they propagate at all, they may revert again to their parental species, especially if the very probable supposition be true, that, when the ovary of these hybrids is fertile, the pollen is inert.

99. Verbena paniculato-stricta: more hirsute than *V. paniculata*, but not canescent like *V. stricta;* leaves much narrower than in *V. stricta*, subsessile or decurrent in a short petiole, simply or doubly or incisely serrate; spikes more crowded than in *V. paniculata*, more fascicled, not paniculate; calyces hairy, somewhat gray, longer than in *V. paniculata;* corolla intermediate in size and color, much paler than in *V. paniculata;* style persistent for some time on the ripening fruit, as in *V. paniculata.*

Grows in abundance on the sandy, sometimes overflowed, banks of the Mississippi, opposite St. Louis, with other hybrid forms, and with *V. stricta*, *V. urticæfolia*, and *V. bracteosa*. *V. paniculata* is very rare there, perhaps destroyed by the growing bushes, which now cover the formerly grassy spots. Nevertheless, the narrow leaves, deeper colored flowers, and persistent style, prove sufficiently that *V. paniculata* is one of its parents. Flowers in July and August.

100. Verbena urticæfolio-bracteosa: decumbent like *V. bracteosa*, but large, spreading sometimes two or three feet; leaves small, like *V. bracteosa*, laciniate; spikes fascicled, filiform; flowers distinct, as in *V. urticæfolia;* bracts longer than the calyx, but not more than half as large as in *V. bracteosa;* corolla larger than in *V. urticæfolia*, with a longer tube, very pale purple.

The parents of this hybrid cannot be mistaken; the growth, the leaves, the bracts of one, and the spikes, and the smaller size and paler color of the corolla of the other.

On sand-bars and sandy islands in the Mississippi (St. Louis) and Illinois rivers, (Beardstown.) Flowers July to September.

101. Verbena stricto-urticæfolia: an interesting hybrid between two very distinct species. The plant is more canescent than *V. urticæfolia;* the leaves shorter petioled, sometimes nearly sessile, of firmer texture, and not simply serrate, but generally doubly or even incisely serrate; sometimes even so much incised or lobed that I would have been inclined to look to *V. hastata* or *V. bracteosa* for an explanation, but we cannot admit the action of three species in the formation of hybrids. The spikes are filiform, the

flowers compacter than in *V. urticæfolia*, but not as densely imbricated as in *V. stricta* or *V. paniculata;* the calyx much longer than in *V. urticæfolia*, canescently hairy; corolla large, intermediate in size between both parents, and pale purple.

This is the most abundant hybrid here, and both parents are amongst the most common weeds about St. Louis. Flowers in July and August.

102. Verbena urticæfolio-paniculata: leaves petioled, lanceolate, with simple, double, or sometimes incised serratures, generally elongated; spikes thin, more properly filiform than in any of our species; calyx and corolla intermediate in shape, size, and color, between both parents. It resembles some varieties of the true *V. paniculata*, but the dark purple flowers, and the thick cylindric fruiting spikes, at once distinguish it.

St. Louis and Beardstown; grassy places and open woods. July and August.

Besides these four hybrids, I have found here the corresponding ones more nearly resembling the other parent, which I designate by the same names, reversing the order, viz.

Verbena stricto-paniculata: greener, narrower, more petioled leaves, darker flowers, than *V. paniculato-stricta.*

V. bracteoso-urticæfolia: adscendent, with large lobed leaves, and thinner spikes.

V. urticæfolio-stricta: canescent, with sessile leaves, and thin filiform spikes.

V. paniculato-urticæfolia: with broader leaves, thinner spikes, paler and smaller flowers.

Then there is the *V. angustifolio-stricta* and *V. stricto-angustifolia.* Hybrids of *V. angustifolia* with any but *V. stricta*, and of *V. bracteosa* with any but *V. urticæfolia*, or of *V. Aubletia*, the only remaining species in this region, I have not yet found. The only other hybrid found by me in this country, is *Rumex obtusifolio-crispus.* Whether these introduced plants hybridize in their native country is unknown to me.

103. Androsace occidentalis, Pursh.
104. Lysimachia revoluta, Nutt.
105. Plantago cordata, Lam.
106. Polygonum tenue, Michx.
107. Polygonum sagittatum, Linn.
108. Croton glandulosus, Linn.
109. Borya ligustrina, Willd.
110. Quercus nigra, Willd.
111. Quercus alba, Linn.
112. Quercus castanea, Muhl.

113. Salix Muhlenbergiana, Willd.
114. Salix nigra, Marsh.
115. Salix longifolia, Muhl.
116. Salix rigida, Muhl.?

117. Potamogeton diversifolius, Barton, β. spicatus. This form appears at first view to be a distinct species, characterized by the narrower, only 5-nerved upper leaves, and petioled oval or cylindric spikes. *P. diversifolius*, α. *capitatus*, the common form, has more oval 7-nerved upper leaves, and nearly sessile few-flowered heads. But sometimes the lower heads of our variety are also capitate and nearly sessile, and the fruit is generally alike. The fruit, or nut, is always compressed, winged on the back, with two lateral carinæ, which are generally denticulate, the nut appearing muricate; and in β. they are often nearly or entirely undivided, but by no means generally so. The embryo describes 1½ of a spiral circumvolution; the embryo of most other species forms only ¾, 1 or 1¼ circumvolution. I know but one species, *P. densus*, which exhibits 2½ circumvolutions.

It may not be amiss here to remind botanists in this country, that the ripe fruit furnishes the best characteristic marks to distinguish the different species of Potamogeton. The fruit, for example, proves that *P. marinus*, Linn. is entirely distinct from *P. pectinatus*, Linn., with which most authors confound it; *P. marinus* occurs not only on the sea-coast, but also in the salt-ponds of the Upper Missouri, (Geyer, in Nicollet's expedition.) Specimens of Potamogeton should always be collected with ripe fruit.

118. Phalangium esculentum, Nutt.
119. Trillium recurvatum, Beck.
120. Juncus marginatus, Rostk.
121. Dulichium spathaceum, Pers.
122. Cyperus kyllingæoides, Vahl.
123. Isolepis capillaris, Rœm. & Schult.
124. Heleocharis tenuis, Schult.

125. Eriophorum gracile, Koch, in Roth. catalect. 2. p. 259. A species which has frequently been found in the United States; it appears to have been taken for *E. angustifolium*—my specimens at least, received from Pennsylvania and from Ohio, were so labelled—but is easily distinguished by its triquetrous, subulate leaves, and the linear yellowish seeds. The true *E. angustifolium*, Roth, is the largest of all the species, with the longest (1½ inch) wool; leaves 1 or 1½ lines broad, channeled; pedun-

cles smooth. *E. latifolium*, Hoppe, (*E. polystachyum*, Auct.) has flat leaves and scabrous peduncles; and both have obovate, dark or light brown seeds.

I propose the following disposition of these species, acknowledging however that I have studied the American varieties from dried specimens only, never having observed any living ones.

E. latifolium (Hoppe): culmo trigono, foliis planis apice triquetris, spiculis plurimis, pedunculis scabris, nucibus obovatis. *E. polystachyum*, β. Linn.

α. *nigro-carinatum:* squamis floriferis plumbeis, carina nigricante, nucibus acutiusculis brunneis. Germany; probably throughout Europe.

β. *viridi-carinatum:* squamis floriferis obscuris, carina virescente, nucibus obtusis, lutescentibus. Massachusetts, Ohio.

E. angustifolium (Roth): culmo teretiusculo, foliis canaliculatis apice triquetris, spiculis pluribus, pedunculis lævibus, nucibus oblanceolatis acutis. *E. polystachyum*, α. Linn.

Squamæ floriferæ nigro-carinatæ, albo-marginatæ. Europe. I have not seen any American specimens.

E. gracile (Koch): culmo obsolete trigono, foliis triquetris, spiculis pluribus, pedunculis scabris, nucibus linearibus (flavicantibus). *E. polystachyum*, γ. Linn. *E. triquetrum*, Hoppe.

α. *plurinervium:* pedunculis tomentoso-scabris, squamis floriferis pallidis, nervis pluribus pallidioribus striatis, nucibus obtusiusculis. Germany.

β. *paucinervium:* pedunculis scabris, squamis floriferis pallidis, nervis paucis (3) pallidioribus notatis, nucibus acutis. Illinois, Ohio, Pennsylvania.

126. Carex rosea, Schk.
127. Carex multiflora, Muhl.
128. Carex arida, Torr. & Schw.
129. Carex cristata, Torr. & Schw.
130. Carex Willdenovii, Schk.
131. Carex Torreyana, Dew.
132. Carex Shortii, Torr.
133. Carex laxiflora, Lam.?
133. Carex Meadii, Dew. in Sill. Journ. Vol. XLIII, p. 90.
135. Carex umbellata, Schk.
136. Panicum virgatum, Linn.
137. Panicum pubescens, Lam.
138. Panicum scoparium, Lam.
139. Panicum clandestinum, Linn.
140. Digitaria filiformis, Ell., var. floribus majoribus.
141. Aristida stricta, Michx.
142. Melica speciosa, Muhl.?
143. Festuca nutans, Willd.
144. Diarrhena Americana, Pal. de Beauv.

145. Atheropogon apludoides, Muhl.

146. Atheropogon papillosus (n. sp.): culmis cæspitosis basi foliatis; foliis lanceolato-linearibus planis margine et ad nervum medianum infra supraque ex papillis serrato-ciliatis; spicis 1–3 subterminalibus biserialibus unilateralibus multifloris; glumis papilloso-hispidis; valva corollæ perfectæ exteriore trifida, valva corollæ neutrius brevissima hyalina ex basi triaristata.

Sandy soil, Beardstown, Ill.—Very near *A. oligostachyus*, Nutt., and resembling it closely, but distinct by the broader and hispid (not setaceous and smooth) leaves, the hispid (not pubescent) glumes, and the hyaline glume of the abortive floret (not half as large as in *A. oligostachyus*.)

147. Andropogon scoparius, Michx.

148. Poa hirsuta, Michx.

149. Poa pectinacea, Michx.?

149, *b*. Hordeum pusillum, Nutt.

150. Woodsia Perriniana, Hook.

ART. XIV.—*On the Mode of Formation of the Tails of Comets;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

IT is not my design, in the present article, to furnish a complete theory of the process by which the tails of comets are formed from their heads. This cannot be attempted, it is presumed, with any reasonable hope of success, until more facts relative to the structure and phenomena of comets have been accumulated. But little more will now be undertaken, than to disprove the commonly received notion that the tail and head of a comet form one connected mass, revolving as one body, and to establish the opposing doctrine, that the tail is made up of particles of matter continually in the act of flowing away from the head. To do this intelligibly and effectually, however, it will first be necessary to treat briefly of the

Physical Constitution of Comets.

What I have to offer upon this preliminary topic, may be conveniently arranged under the following heads; viz. 1. The na-

ture of comets. 2. Their structure. 3. Their variations in form and dimensions.

1. *The nature of Comets.*—It is well known that it has long been considered an established fact in astronomical science, that the cometary bodies are collections of matter which is far more subtil in its texture than the lightest gas, or the most evanescent vapor. There are visionary theorists, however, who, not content with the mere shadow of materiality which astronomers have attributed to these bodies, deny them the honors of material existence altogether, seeing in them nothing but fortuitous images. And there are men of science, who with Appian and Tycho Brahe, of old, while they conceive the head to be a real corporeity, maintain that the tail is a mere spectre of light. This latter theory has, it must be allowed, at the first glance, an air of great plausibility; as it is remarkably simple in its conception, and seems to give a ready explanation of the more familiar phenomena. But it would be easy to show that it does not stand the test of comparison with facts, when attentively applied. It would be a work of supererogation, however, to attempt this in the present communication, as there is no evidence that this theory has secured any foothold in the region of true science. I shall accordingly take it to be an admitted fact that the tail of a comet, as well as its head, is a material substance.

Judging from appearances, there is, moreover, no distinction of kind in the matter of which comets are composed. All parts of a comet shine with the same nebulous light, with the exception only of the nucleus; and this often assumes a similar appearance, when viewed through a telescope. If any further evidence be wanted of an identity of nature in the matter of the nucleus and of other parts of the comet, we may find it in the undoubted fact that the nebulous envelope of the head receives frequent supplies from the nucleus. It is not to be overlooked, although, that all this evidence really applies, at least directly, only to the outer parts of the nucleus. The central portions, for any direct proof to the contrary that we have, may be regarded as unchangeably solid, as they have been by Schrœter and some other astronomers. But the existence of comets with very small nuclei and of others with no nucleus at all, furnishes a strong presumption, in confirmation of the natural inference from what is above stated, that

the whole nucleus is composed of the same species of nebulous matter as the other portions of the comet.

The tail, though generally less bright than the nebulosity of the head, is not always so; e. g. the comet of 1843, as seen on the 28th of February.*

Whether comets are self-luminous or shine by reflected light, is a question which, though it has been much discussed, is not yet settled. Since the evidence of a reflection of light, sought for in phases of the nucleus and in signs of polarization in the light received from a comet, has not been found sufficient to establish its existence, Arago proposes another method of research in the case, founded upon observed variations in the intensity of the light, which may perhaps be more successful.

2. *The structure of Comets.*—A cometary body is composed of two connected portions of nebulous matter, called, respectively, the head and the tail. The head consists, in general, of a central nucleus, (although having a greater lustre, composed as we have seen reason to believe, of the same species of matter as the other parts, but in a more condensed state,) enveloped on the side towards the sun, and ordinarily at a greater distance from its surface in comparison with its own dimensions, by a globular nebulous mass, called the *nebulosity*. This, it is said, never completely surrounds the nucleus, except in the case of comets which have no tails. It in fact encircles only that hemisphere of the nucleus which is turned towards the sun. The tail begins where the nebulosity terminates, and seems, in general, to be merely the continuation of this in nearly a straight line beyond the nucleus. There is, ordinarily, a distinct space containing but little luminous matter between the nucleus and the nebulosity, but this is not always the case. From the accounts that have been given of the telescopic appearances of the comet of 1843, it would seem that the nucleus and nebulosity of this comet were seldom visibly separate; what is there called the nucleus, being in fact the nebulosity and nucleus combined. The tail of a comet has the shape of a hollow frustum of a cone, with its smaller base in the nebulosity of the head; with this difference, however, that the sides are usually more or less curved, instead of being straight. They are, in general, concave towards each other, as in the case of the recent

* See American Almanac for 1844, p. 94.

comet as seen on the 28th of February; sometimes perhaps convex. The whole tail is generally bent, so as to be concave towards the regions of space which the comet has just left. This curvature is most perceptible near the extremity of the tail, and has in one instance (that of the comet of 1744) been observed to be as great as 70° or 80°. The envelope of the head is not a hemisphere, but approximates to the form of a hyperboloid, having the nucleus in its focus, and its vertex turned towards the sun. In some instances the nucleus is furnished with several envelopes concentric with it; and sometimes each of these is provided with a tail. Each of these several tails lying one within the other, being hollow, may in consequence appear so faint along its middle as to have the aspect of two distinct tails. A comet that has in reality three separate tails, might thus appear to be supplied with six, as was the comet of 1744. If the different envelopes were not distinctly separate from each other, then we should have all the tails appearing to proceed from the same nebulous mass.

3. *Variations in the form and dimensions of Comets.*—It is well known that both the head and tail of a comet are subject to great changes in their apparent dimensions, and frequently some slight changes of form, during the period of its visibility, which have an obvious relation to the distance of the comet from the sun. These changes cannot be attributed to the variations in the amount of light received from the sun; for, in the first place, they are too irregular, and, in the next place, the length of the tail, as well as the intrinsic lustre of the whole comet, continue to increase until some time after the perihelion passage. The nebulous envelope of the head moreover, increases in its dimensions as the comet departs from the sun. It follows, therefore, that a comet is not a body of invariable size, like the planets, and that the tail is actually formed out of a portion of the matter of the head, as it appears to be; and this by the operation of some cause whose action depends upon the distance of the head from the sun.

Such are most of the facts appertaining to the physical constitution of the cometary bodies which will be employed in the discussion upon which I propose to enter. Their importance in the present connection, must be my apology for occupying the pages of a Journal of Science with the recital of facts, for the most part, long since established.

Mode of Formation of the Tails of Comets.

To proceed with due caution, in approaching the field of inquiry before us, we must seek for some solid ground to advance upon. This may be found in the following statements. 1. The general situation of the tail of a comet with respect to the sun, shows that the sun is concerned, directly or indirectly, in its formation. We have seen too, that the changes which take place in the dimensions of a comet, both in approaching the sun and receding from him, conduct to the same inference. 2. Since the tail lies in the direction of the radius-vector prolonged beyond the head, the particles of matter of which it is made up, must have been driven off from the head by some force exerted in a direction from the sun. 3. This force cannot emanate from the nucleus, for such a force would expel the nebulous matter surrounding the nucleus in all directions, instead of one direction only. This objection, it is true, would be obviated, if a repulsive action were to be exerted by the nucleus only, from that hemisphere which is on the side opposite to the sun; but it will be at once perceived that such a force as this would not give the tail the form and direction which it is known to have, when it is considered that the tail has its origin in the nebulosity at the side of the nucleus. A repulsion from the nebulosity is also out of the question, as, on this supposition, the matter would be expelled outwards in all directions. In fact no one force having its origin in the head of the comet, can be conceived of, that would be adequate to the production of the tail. A tangential force at first view, might seem to be, but this would only form a tail proceeding from one side of the nucleus. The idea of two or more tangential forces can hardly be entertained, as, besides its inherent improbability, it involves the idea of matter in different states, or of different kinds in different parts of the tail, for which we have not the least shadow of evidence. It is possible however, as we shall see farther on, that a repulsive action of the nucleus upon the matter of the nebulosity, may be combined with some other force foreign to the comet, as an auxiliary cause in producing the phenomena of the tail—its effects on the side towards the sun being contracted, at a certain distance from the nucleus, by this latter force.* 4. There seems, then, to be little room to doubt

* Although, as I have asserted in the context, there is no one force immediately related to the nucleus that can form the tail, it is perhaps possible to conceive of

that the matter of the tail is driven off from the head by some force foreign to the comet, and taking effect from the sun outwards. 5. This force, whatever may be its nature, extends far beyond the earth's orbit. For comets have been seen provided with tails of great length, though their perihelion distances exceeded the radius of the earth's orbit, (e. g. the great comet of 1811.) Nothing can be predicated with certainty with respect to the law of variation of this force, but it is at least probable, that, like all known central forces, it varies inversely as the square of the distance.

I do not now propose to discuss the question of the nature of this force by which cometic matter is expelled in a direction opposite to the sun—that is, whether it consists in an impulsive action of the sun's rays, as Euler imagined, or in a repulsion by the mass of the sun, operating at a distance, as supposed by Olbers and Bessel. I would only remark, that as experiment has failed to discover any impulsive force in the sun's light, the choice must be given to that one of the two views which best explains the phenomena. Whatever may be the nature of the force in question, I will call it *the repulsive force of the sun.* Granting its existence, there are two modes in which we may conceive it to operate in forming the tail. We may suppose that it drives off the nebulous matter to greater and greater distances, without destroying the connection of the parts; so that the tail and the head will always be revolving as one connected mass. Or we may conceive that it is continually detaching portions of the nebulosity, and repelling them to an indefinite distance into free space. The first mentioned conception is the theory which has been in vogue hitherto. But it seems to me that there are good and sufficient reasons for rejecting it, and adopting the other in its stead. These it will be my object now to give.

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two such forces adequate to its production. Thus, we might imagine a very rapid flow of the more elevated portions of the nebulous matter from the hemisphere turned towards the sun around to that which is turned away from him, by the mere effect of heat and cold, and that, on reaching this hemisphere, the particles are driven off by the action of a repulsive pole. Something of the same sort might be conceived to be in operation on the earth. Thus we might imagine some subtil fluid flowing from the equator, and accumulating about the poles, and subsequently expelled in detached portions by the repulsion of the magnetic poles, forming the streamers of the aurora borealis and aurora australis; but to such speculations there is no end.

1. There appears to be no satisfactory reason to be assigned why the force which expels the nebulous matter to the end of the tail should not urge it still farther. Let us take the case of the comet of last year. The extremity of its tail was, at one time, at about the same distance from the sun as was the nucleus of the great comet of 1811, a while after its perihelion passage; when it had a bright tail more than a hundred millions miles in length. The force that was sufficient to expel such a quantity of nebulous matter from this latter comet, ought it not to have driven still farther the much rarer matter at the remote parts of the visible tail of the comet of 1843? A resisting medium might give a limitation to the velocity of flow, but could not destroy it altogether.

2. In the case of the comet of last year, the repulsive force of the sun, which, by the theory in question, is supposed to keep the tail continually opposite to the sun, or nearly so, could not have been of sufficient intensity to do this, without materially deranging the orbit. If this cannot be proved to a mathematical certainty, it can, at least, be rendered highly probable; as I will now proceed to show.

If the head and tail of a comet revolve together as one mass, it must be the centre of gravity of this mass that describes the parabolic orbit; and moreover, since the tail keeps continually opposite to the sun, this mass must rotate about its centre of gravity, at the same rate that the centre revolves around the sun. If the tail be conceived to fall somewhat back of the line of the radius-vector prolonged, as it does in point of fact, then, it may chance that the sun's repulsive actions upon the varying parts of the comet may give a resultant, having its line of direction so situated, behind the centre of gravity, as to tend to produce the rotation required. If we could find the situation of this resultant, for any assumed inclination of the tail to the radius-vector, produced beyond the orbit, as well as the expression for the moment of inertia of the whole mass divided by the mass, then, as the angular velocity of rotation would be known at each point of the orbit, being the same as that of revolution, we might, by a well known formula of mechanics, easily compute the velocity of translation that would be given to the centre of gravity of the rotating mass by a force of sufficient intensity to produce the rotation. Afterwards it would be easy to find whether this

velocity would carry the body to a perceptible distance from the parabolic orbit. These calculations cannot, however, be made with any pretension to accuracy, for want of the requisite data. Still we can make such suppositions as will almost infallibly give a result less than the truth, which will serve our present purpose equally well. Let us suppose, then, the comet to be at its perihelion, and with the view of making the computation above referred to, seek for some safe conclusion as to the length of the tail at that point.

In solving this inquiry, the first consideration that I would present, is that the apparent length of the tail gives no certain indication of its actual length. This is manifestly true when the comet is seen in the day time, as was the recent comet on the 28th of February, for, we know that the part of the tail near the head, when a comet is seen at night, is in general brighter than the other parts. That we never see all of the actual tail, even at night, may be inferred from the fact that the apparent length is very different as seen from different places. For example, it is said that "the tail of the comet of 1759, appeared at Paris to be only 2° or 3° in length; but at Montpelier 25°. The comet of 1769 at Paris seemed to have a tail 60° long; but at Boulogne 70°; and at the Isle of Bourbon 97°." The same inference may be drawn from the circumstance that the light diminishes gradually, from the head to the extremity of the apparent tail. In fact, certain observations made upon the recent comet seem to show, that the actual quantity of matter in a section perpendicular to the axis, was about the same at the extreme end of the tail as in the vicinity of the head. Thus, on the evening of the 11th of March, this comet was barely discernible at this place, ten minutes after the three stars in Orion's belt came distinctly into view, which would make its brightness about equal to that of a star of the third magnitude. That it was not greater than this is evident from the fact that the tail was less bright than the nucleus, which had about the same lustre as the star Zeta Ceti, of the third magnitude. It was observed also that the extremity of the tail was about twice as broad as the most luminous part of it, which was not far from one sixth of the length distant from the nucleus: and I find that the ratio of the distances of these parts from the earth, was very nearly as 3 to 2. From which it appears that the tail was three times broader at its extremity than at the

part which gave the most light. This result may be tested by a comparison with the results of other observations. Thus, the breadth of the tail at its extremity, on the same evening, was estimated to be a little less than 3°. Taking it at 3°, I find the actual breadth to have been 7,040,000 miles. Now according to Mr. Caldecott, of the Royal Observatory at Trevandrum, the nebulosity several days after the perihelion passage was 20,000 miles in diameter; and Prof. Bartlett, of the U. S. Military Academy, found its diameter to be nearly 40,000 miles, on the 29th of March. Taking either one of these numbers for the diameter on the 11th of March, we find the point of the tail at which the breadth was one third of that of the end, to be very nearly at the distance of one third of the length of the tail, from the head—within $\frac{1}{35}$ of this length if the first number be used. The inclination of the sides of the tail, on the 3d of March, as determined by Piazzi Smyth, Esq., of the Royal Observatory at the Cape of Good Hope, and corrected for the obliquity under which the angle was viewed, furnishes a similar result for that date. It would seem therefore that the variation of breadth must have been at least as great as the estimate on the 11th of March would make it. This being allowed, I remark that this increase of breadth in the proportion of 1 to 3, if we suppose the quantity of matter to have been the same in each section, ought to have made the light at the extremity three times less, provided there had been no variation in the inclination of the line of sight to the line of the tail. The variation in this angle which actually obtained, reduces the ratio just given to 2.44. This supposes however that the quantity of light emitted, varies only with the density of the cometic matter. But, if we adopt the theory most in vogue, that comets receive their light from the sun, there must be an increase of this ratio in the proportion of 4 to 1. We thus obtain as the final result 9.76. Now we have seen that the brightest portion of the tail gave about as much light as a star of the third magnitude. To compare this intensity of light with that at the extremity, it is only necessary to observe that, the moon being little past her first quarter on the evening of the 11th of March, stars of the fifth magnitude were scarcely, if at all discernible, and then to employ the experimental comparisons of the light of the stars, obtained by Sir William Herschel. In this way we find the ratio of intensities to have been as 1 to 4. Some allowance

however, should be made for the light intercepted by the atmosphere, which was the greatest at the lowest of the two points considered. It is believed that doubling the ratio just found will suffice for this. This being done we obtain for the actual ratio, 1 to 8, which corresponds very nearly with the ratio computed on the supposition of the existence of an uniformity in the absolute quantity of matter. The observations of the 28th of February, seem also to be in accordance with this supposition. The comet was seen on that day in the immediate vicinity of this place by a very intelligent individual, who informs me that the head was a little smaller than the sun, (certainly not larger,) and that the tail was as much as three times broader, at its extremity, than at the head. The whole comet is described as being similar in form to an ox-bow or the letter U, only that the branches were more divergent—the sky appearing even darker between them than any where else. The observations at Woodstock, Vt., make the variation of breadth a little greater, if we assume the size of the head to have been only $\frac{1}{2}°$. It must certainly have been less than 1°, as there was a very marked divergence in the sides of the tail, and the average breadth was not estimated by any of the observers higher than 1°. Agreeably to our supposition, therefore, there must have been a decrease of light, from one end of the comet to the other, in the ratio of 3 to 1; and, if we conceive the light to be derived from the sun, it will become as 12 to 1—which is about the ratio of the quantity of light given by a star of the third, and one of the fifth magnitude, or by stars respectively of the first magnitude and intermediate between the third and fourth. It is moreover quite as great as the observations themselves would seem to warrant us in supposing.*

* The phenomena of the disappearance of the great comet of 1843, as seen in the vicinity of this place (Newark, Del.) on Feb. 28th, are not a little curious. The comet was first noticed at from 9½ to 10 A. M. After having remained visible for about three quarters of an hour, during the latter half-hour of which interval it was almost constantly watched by my informant, in a situation in which the eye was completely protected from the sun, it suddenly began to disappear at the extreme points, without there being any perceptible haziness in the atmosphere. The branches continued to shorten, and in a few minutes were entirely wanting. The comet had now assumed the appearance of a round ball, and glowed with a more intense lustre than before. This latter fact is particularly insisted on. This round ball gradually contracted until it became a mere bright point, and then disappeared—producing the impression that it was moving away into the depths of space. These facts, as well as those mentioned in the context, came accidentally

It appears, therefore, that the most probable conception, to say the least, that can be formed of the distribution of matter in the tail of the recent comet, is that there was the same quantity of matter in each section perpendicular to its axis. And if this conception be in accordance with fact, (in case we have regard only to the absolute quantity of matter, and not to the density, which is all that calculation to be made requires,) it is plain that the tail may, so far as we know, have extended to a vastly greater distance than it appeared to do. As to its probable apparent length at the perihelion, had it been seen in the evening, the lengths observed after this date, in connection with the history of previous comets, would make it, at least, 25,000,000 miles. If it be admitted that the tail was seen by Mr. Walker, at Philadelphia, on the 23d of February, (who represents it to have extended 30° in the heavens,) it must have been more than 50,000,000 miles in length at that date. In view of all these considerations it would seem that we might safely take the actual length of the tail at the perihelion as great as 50,000,000 miles. After having made the calculation upon this supposition it will be easy to determine the effect upon our results of any supposed diminution in the length. In fact, it will be seen that the principal conclusions arrived at cannot be overthrown by any changes, that are at all admissible, in the two hypotheses in respect to the length of the tail and the distribution of its matter, that have been adopted.

Another requisite datum, in the calculation, is the proportion between the quantities of matter in the head and tail of the comet. It appears that the nucleus, as seen by the different observers had not the appearance of being a solid. Amici of Florence, who saw the comet on Feb. 28th, compares the whole mass, without making any distinction between the nucleus and the tail, to "a flame:" and Mr. Clarke of Portland, compares its appearance on the same day, to "a white cloud of great density." Other accounts convey a similar idea. Mr. Clarke also represents the nucleus to have been no brighter than the tail. From his account and Amici's, it may certainly be inferred that there was no mate-

to my knowledge some three months after the date at which the comet was seen; and so much time was afterwards consumed in the endeavor to identify the date that it was concluded to defer their publication to the present time. I have found it impossible to fix upon the day with positive certainty: but a collection of all the circumstances, leaves little room to doubt that it was the 28th of February. [The true date is probably the 27th; for, the comet was certainly seen on the 28th as late as 3 P. M.: see this Journal, Vols. XLIV, 412: XLV, 230.—EDS.]

rial difference between the brilliancy of the nucleus and that of the nebulosity and of the parts of the tail nearest the head. According to the determinations of Mr. Caldecott, as Prof. Peirce informs us, the diameter of the nucleus several days after the perihelion passage was 5,000 miles. (At this time the nucleus shone with a stronger lustre than the tail, and generally, indeed, after the 28th of February.) Judging, then, from the appearance of the comet on Feb. 28th, and the relative size of the head and tail, we should infer that there was less matter in the former than in the latter. Mr. Walker also quotes the great astronomer, Bessel, as saying "this comet seems to have expended the greater part of its nucleus in building up its splendid tail." This statement was made on the 28th of March. Whatever may have been the actual length of the tail at the time of the perihelion passage, it cannot be doubted that it received considerable accessions of matter afterwards. It is to be observed, however, that the increase in the length of tail seen, is in fact attributable to the increased obliquity under which it was viewed in receding from the earth. Taking all that has now been stated into account, it would seem to be a large allowance to regard the nucleus and nebulosity as containing a thousand times more matter than the tail.

Now let w = the angular velocity of rotation, that is, the space passed over in the unit of time (one second) by a point at the unit of distance (one mile); v = velocity of translation of centre of gravity; p = arm of lever of the resultant of all the forces of rotation acting upon the various parts of the comet; and k^2 = moment of inertia with respect to the centre of gravity of the whole mass of the comet, divided by the mass; then we have, from mechanics, $v = \frac{k^2 w}{p}$, (1). We will first find the value of k^2. Whatever may be the breadth of the tail, and whatever its precise form, its moment of inertia will be diminished by supposing all the particles to approach its axis. (I conceive, for reasons already given, each section of the tail to contain the same quantity of matter.) It is therefore allowable to imagine the whole mass of the tail to be condensed upon the axis, so as to form one heavy line of uniform density. The middle of this line will be the centre of gravity of the tail. Let x = distance of any point of this line from the centre of gravity; l = half the length

of the tail; m = moment of inertia of any portion of the tail, and m' = moment of inertia of the whole tail; then, $m = \int x^2 \times dx = \frac{x^3}{3} + c$. Integrating between the limits $x = 0$, and $x = l$, we have $\frac{m'}{2} = \frac{l^3}{3}$, and $m' = 2 \cdot \frac{l^3}{3}$, (2). As we are ignorant of the dimensions of the head at the time of the perihelion passage, for which the calculation is to be made, we will neglect its moment of inertia with respect to its centre, which on any admissible supposition is but a very small fraction of the moment of inertia of the tail, and will, so far as it has any effect, only make v, the velocity of translation, the greater. $2l$ = mass of the tail; and $1000 \times 2l + 2l = 1001 \times 2l$ = whole mass. Put b = distance of centre of gravity of whole mass from centre of nucleus, and a = distance of same point from the centre of gravity of tail. (b = 24,975 miles = 25,000 miles (nearly); a = 24,975,025 miles.) Also let M = moment of inertia of whole mass—neglecting as above. Then, by the principles of mechanics, $M = 2 \cdot \frac{l^3}{3} + 2l \times a^2 + (1000 \times 2l) b^2$: and $k^2 = \frac{2 \cdot \frac{l^3}{3} + 2l \times a^2 + (1000 \times 2l) b^2}{1001 \times 2l} = \frac{\frac{l^2}{3} + a^2 + 1000 b^2}{1001}$, (3). Making the calculation we obtain $k^2 =$ 831,876,980,528.

Next, to find w, I take the formula for a parabolic orbit, $t = D^{\frac{3}{2}} \sqrt{\frac{2}{m}} (\text{tang.} \frac{1}{2} u + \frac{1}{3} \text{tang.}^3 \frac{1}{2} u)$, (4); in which t = time elapsed since the instant of the comet's arrival at its perihelion, or a certain interval before; u = anomaly corresponding to the time t; D = perihelion distance; and m = intensity of sun's attraction at the unit of distance. Taking 1 = radius of earth's orbit, and one day for the unit of time, $m = 0.00030$; D = 0.005263 (= 500,000 miles): and making $u = 90°$, t = one hour (very nearly). But, as there is some uncertainty in the perihelion distance, we will take $t = 1\frac{1}{2}$ hours, or $2t = 3$ hours. During this interval of three hours, in which the comet passed from 90° on one side of the perihelion to 90° on the other side, the average angular velocity of revolution was 0.000291 of a mile per second. Equation (4)

gives 0.00066 of a mile for the angular velocity at the perihelion, little more than twice the average velocity. But as the tail probably fell back somewhat while the comet was passing around the sun, we will take the angular velocity of rotation at the perihelion no greater than 0.000291 of a mile, the average velocity above given. It cannot have been much less than this, for if we suppose it to have been one half less, then, while the motion of revolution in the interval $2t$ was 180°, that of rotation would have been only 45°, and thus the tail would have been nearly perpendicular to the radius vector when the comet was at its perihelion, and have fallen far within the orbit an hour and a half afterwards, which is opposed to all analogies. The velocity really taken makes the deviation at the latter date as much as 90°.

Now, substituting the values of w and k^2 in equa. (1), we get $v=\frac{242,076.201}{p}$, (5). It still remains to find the value of p. Supposing that the sun's repulsive force takes effect only upon the tail, and is the same in the same angular space, which is the case with all central emanations, so far as known; also that the deviation of the tail from the position of opposition to the sun is 45°, the resultant of the sun's actions will bisect the angle subtended by the tail, and will act with an arm of lever equal to 188,110 miles. For a deviation of 90° the leverage will be nearly twice as great. It will be seen farther on, that the supposition that the repulsive force keeps the tail continually opposite to the sun, requires that this force should vary more rapidly than central forces in general, which would make the arm of lever still less. The value of p, just found, being substituted in equation (5), we obtain, finally, $v=1287$ miles. This is the velocity of translation due to an instantaneous force of impulsion acting with the above arm of lever, and of such intensity as to give a velocity of rotation equal to the average velocity of revolution during the period of three hours employed by the comet in passing immediately around the sun. It would also be the velocity due to the supposed repulsion of the sun acting up to the time of the perihelion passage, if this had always retained the same direction.* But as it did not, we have now to seek

* The arm of lever would be very nearly the same in the different positions of the comet, for the same length of tail and the same deviation. The change of length of the tail may be neglected.

for the effect of its change of direction. For greater simplicity, let us confine our attention to the hour and a half immediately preceding the perihelion passage. In this interval three fourths of the angular velocity of rotation which obtains at the perihelion is received, and thus three fourths, or nearly so, of the velocity of rotation at the same point. We will, in the first place, conceive the force to act continually with its average intensity, and, at the same time, the motion of revolution to be uniform at its average rate; then, the resultant of the increments of velocity imparted in the different instants of the interval considered, will be to the sum of these same increments as the chord of 90° is to the quadrantal arc, as $\sqrt{2}$ to 1.5708, as 0.89 to 1, and it will be inclined 45° to the axis of the parabolic orbit. Next, to solve the actual case, we must seek for the law of variation of the supposed repulsive force of the sun. Let the force in question be denoted by q, and we have $q=\frac{dv}{dt}$. Now the motion of rotation is constantly the same as that of revolution, and thus the angular velocity of rotation $=v=\frac{1}{r^2}$. Hence $dv=-\frac{2dr}{r^3}$. We also have, from the parabolic orbit, $dt=\frac{-rdr}{\sqrt{2m(r-D)}}$, (the time being reckoned from the aphelion.) Whence $q=\frac{2dr\sqrt{2m(r-D)}}{r^3\times rdr}$ $=\sqrt{8m}\,.\,\frac{\sqrt{r-D}}{r^4}$. We learn from this expression that the force q equals zero at the perihelion, and attains to its maximum value, $41\frac{1}{2}°$ from the perihelion, where $r=\frac{9}{7}D$: also that the variation of its intensity is according to a more rapid law than that of the inverse squares. It will be seen, therefore, that its entire effect during the hour and a half which immediately precedes the instant when the comet is at its perihelion, is greater than the approximate value of this, found above, and is in pretty nearly the same direction. We may therefore make use of the approximate value instead of the true, in seeking for the effect in double the interval just mentioned, as the result will be less. Multiplying then the value of v which has been found by 0.89 and by $\sqrt{2}$, we obtain the quantity sought; viz. $v=1214$ miles (per second) in the direction of the axis, outwards from the orbit. The subsequent action of the force will only slightly diminish this velo-

city. Now $\frac{1}{6}\frac{1}{0}$ of a mile would give in twenty days an apparent displacement in the plane of the orbit of about half a minute of an arc, which is more than the difference between the observations and the best ephemeris. From which it appears, that if the force necessary to keep up the rotation were to be diminished more than seventy thousand times, its effect upon the orbit ought still to have been perceptible.

If we were to suppose the tail to have been only 4,000,000 miles long, while the comet was nearest the sun, which is not much more than half its length, as seen in the day time on the 28th of February, then the velocity found as above, would be about one hundred and fifty times less; which would still be about four hundred and seventy times too great. To reduce it as low as is necessary we must then suppose, farther, that there was four hundred and seventy times more matter in the head of the comet.

If we imagine, as some astronomers have done, the only bond of connection between the different parts of the comet to be that of gravitation, the force will have to be the same, and it will have the same effect upon the motion of the centre of gravity.

There is another mode in which the supposed entire connected mass of a comet may be conceived to be set in rotation, besides that which we have been considering, viz. by the action of the excess of the sun's attraction for the nearer over that for the more remote parts of the comet. Let us attempt its investigation. It will be observed that this force cannot alter the orbit, and that the only inquiry will be whether it is of sufficient intensity to produce the known rate of rotation. Now let G = resultant of the differences between the sun's actions upon the various points of the tail, and his action upon the extremity supposed distributed over the whole length; Y = distance of point of application of this force from the sun; g = sun's force of attraction at the unit of distance; D = distance of nucleus from the sun; d = distance of extremity of tail; and x = distance of any point in the tail: then, $\int \frac{g}{x^2} . xdx$ = sum of moments of forces soliciting the different particles; and $\int \frac{g}{d^2} . xdx$ = sum of moments of forces equal to force at the extremity of the tail. This being the case, we may proceed with the investigation as follows; GY =

$\int\frac{g}{x^2}\cdot xdx-\int\frac{g}{d^2}\cdot xdx=g\log.x-\frac{g}{d^2}\cdot\frac{x^2}{2}+C.$ $C=-g\log.D+\frac{g}{d^2}\cdot\frac{D^2}{2}$; whence $GY=g\log.\frac{x}{D}-\frac{g}{d^2}\cdot\frac{x^2}{2}+\frac{g}{d^2}\cdot\frac{D^2}{2}$. Integrating between the limits $x=D$, and $x=d$, we have, $GY=g\log.\frac{d}{D}-\frac{g}{d^2}\cdot\frac{d^2}{2}+\frac{g}{d^2}\cdot\frac{D^2}{2}=g\log.\frac{d}{D}-\frac{g}{2}+\frac{g}{2}\cdot\frac{D^2}{d^2}$ and $Y=\frac{g}{G}\cdot\log.\frac{d}{D}-\frac{1}{2}\cdot\frac{g}{G}+\frac{1}{2}\cdot\frac{g}{G}\cdot\frac{D^2}{d^2}$, (6). Now to find G; $G=\int\frac{g}{x^2}dx-\int\frac{g}{d^2}dx=-\frac{g}{x}-\frac{g}{d^2}x+C$; and $C=\frac{g}{D}+\frac{g}{d^2}D$. Substituting and integrating between the limits $x=D$, and $x=d$, we obtain $G=\frac{g}{D}-\frac{g}{d}+\frac{g}{d^2}D-\frac{g}{d^2}d$, (7). Hence $Y=\frac{g\log.\frac{d}{D}-\frac{1}{2}g+\frac{1}{2}g\frac{D^2}{d^2}}{\frac{g}{D}-\frac{g}{d}+\frac{g}{d^2}D-\frac{g}{d^2}d}=\frac{\log.\frac{d}{D}+\frac{1}{2}\frac{D^2}{d^2}-\frac{1}{2}}{\frac{1}{D}-\frac{1}{d}+\frac{D}{d^2}-\frac{1}{d}}$, (8). Making the calculation for the perihelion, (taking the perihelion distance = 1,) we get $Y=4.19183=2{,}095{,}915$ miles. Equation (7) gives $G=0.989g$; g=weight of unit of length of tail at the unit of distance. Now we find that the sun's attraction for the head exceeds that for the tail in the ratio of 102,042 to 1: thus, dividing Y – 500,000 miles in this ratio, we have for the distance of the point of application of sun's force from the centre of the nucleus, 15.6 miles. The distance of this point from the centre of gravity will then be 24,975 – 15=24,960 miles. Assuming the deviation of the tail from the line of the radius-vector to be as great as 45°, the arm of lever of the force will then be 17,652 miles. Substituting this for p in equation (5), we get $v=13{,}713$ miles. Three fourths of this, or 10,284 miles, will then be the velocity of translation due to a force acting with the above mentioned arm of lever, continually in the same direction, and of sufficient intensity to impart the additional velocity of rotation received during the hour and a half which immediately precedes the perihelion passage. Now, to obtain the velocity due to such a force acting after the same manner as the sun; I find, by calculation, that the portion of the latter force which acts upon the tail is about one half less 90° from the perihelion. Since, however, this is only from the $\frac{1}{3\,6\,0}\frac{1}{0\,0\,0}$ to the $\frac{1}{1\,8\,0}\frac{1}{0\,0\,0}\frac{1}{0\,0\,0}$ part of the force acting upon the head in the different

positions, the law of variation of the whole attraction considered, will not sensibly differ from that of the accelerating force of the comet in its orbitual motion. The arm of lever will also remain very nearly the same. Thus, proceeding as on page 117, we shall have an approximate value of the velocity sought, viz. 9,153 miles. Multiplying by $\sqrt{2}$, we find for the velocity in the interval of three hours 12,943 miles (nearly). The average intensity of the accelerating force of the comet in this interval (=0.08614 miles per second) is very nearly the same as that of the force producing the rotation. In three hours this latter force, acting in the varying direction of the radius-vector, will then generate a velocity of 584 miles per second. Whence it appears that it is twenty two times smaller than the force requisite to produce the rotation. But it is to be observed that it would be more correct in the present case to take the true interval answering to the anomaly 90°, as calculated on page 116; which is one hour, instead of one hour and a half. If this be done, the sun's force will be found to be fifty times too small. This result, it will be recollected, answers to the supposition that the tail had a length of 50,000,000 miles at the perihelion. If we suppose its length to have been only 10,000,000 miles, the force of the sun will then be only ten times too small; and a length of 5,000,000 miles will make it six times too small. This deficiency may be made to disappear by supposing the quantity of matter in the head to be about six times greater, or six thousand times more than in the tail. I conclude, therefore, that if the head and tail of a comet revolve and rotate as one connected mass, the force which generates the rotation is the attractive instead of the repulsive power of the sun; for any supposition that will reconcile the observations upon the comet of 1843 with the action of a repulsion, will more than suffice to make the attraction great enough to produce the rotation. But it will be observed that a discussion of the observations upon this comet, in connection with the history of comets in general, has led to the adoption of elements quite different from those which the sun's attraction, considered as the cause of the rotation, requires.

3. Whichever of the two forces that have now been under consideration be conceived to be in action, there would seem to be certain almost inevitable results flowing from their action which are opposed to observation. The first that I would notice

is, that whenever a comet, which has its perihelion near the sun, (as the comets of 1843 and 1680,) sweeps around the sun, the great centrifugal force generated by the amazing velocity of rotation would entirely dissipate the greater part of the tail. It may be well to remark, in this connection, that the supposed rotation of a comet would, in general, dissipate the tail more or less rapidly, unless the particles should be held together by a strong molecular attraction. For, I find, that taking the mass of the head as great as the $\frac{1}{1000}$ part of the mass of the earth, and supposing the rate of rotation to be only 2° per day, the centrifugal force will be equal to the gravitation towards the head at the distance of only 39,000 miles. In the case of the comet of last year, this equality subsisted, at the time of the perihelion passage, at the very small distance of 434 miles from the centre of the nucleus. These examples will serve to show, that on the theory now under consideration the centrifugal force must be supposed to play an important part in the elongation of the tail. Another of the consequences of this theory at variance with observation is, that the velocity of rotation communicated in the approach to the sun, being still retained after the passage of the perihelion, and being continually augmented by the action of the force which is the operative cause of the rotation; when the tail comes up into opposition, it ought soon to get in advance of this position, and more and more from day to day until the velocity of rotation becomes reduced to an equality with that of revolution, by the action of the force on the other side of the centre of gravity. Other considerations might be urged corroborative of the evidence already obtained of the fallacy of the common notion that all the parts of a comet are united into one revolving and rotating mass; but it is time that I proceeded to give a more detailed exposition of the other conception to which I referred in the beginning of this article, and to furnish such direct arguments in support of it as my limits will admit.

The theory that cometic matter continually flowing away from the head of a comet constitutes what is called the tail, first occurred to me while preparing an article on the subject of the recent comet, subsequently published in the Philadelphia Inquirer of April 25th: and it is there given, in its incipient state, as a mere suggestion—the intimation being at the same time given that, although new to the writer, it had, in all probability, previously

occurred to some of the numerous theorists who had speculated upon the mysteries of the luminous appendages of comets. A communication setting it forth with some degree of detail, and offering some arguments in support of it, together with others against the view of the matter generally entertained, was afterwards read before the American Philosophical Society at the celebration of the hundredth anniversary of the Society in May last; a brief abstract of which has since been published in the account of the proceedings had on that occasion. Circumstances beyond my control had hitherto prevented me from making such examinations of astronomical works as to satisfy myself whether the conception which I had formed of the tails of comets was altogether new, and I, accordingly, did not, on this occasion, present any claim to be the originator of it. I have since found that it is a feature of Olbers' more complete theory, as modified by Bessel.* With the fact that Olbers conceived a portion of the matter of the nucleus to be driven off by a repulsion residing in the nucleus I had long been acquainted, but no explanation of the theory that I had met with, represented it as conceiving matter to be flowing off continually to an indefinite distance. Most of the theories that have been promulgated, contemplate the matter of which the tail consists, as having been expelled from the head by some force taking effect in a direction from the sun. There was nothing in the mere assertion of a new operative force to suggest the idea of a perpetual emission, such that there should be at no time any physical bond of connection between the head and tail of the comet; any more than there had been in the assertion of other forces having the same general tendency. I have made this brief historical statement, that it might not be supposed that I had on any occasion urged unfounded claims to priority of discovery. I now proceed to the consideration of the matter in hand; and will begin with a more precise and detailed explanation of the theory. First, then, I conceive that the tail of a comet is made up of particles of matter continually flowing away at a very rapid rate from the head into free space, and that at any one instant we see the collection of all the particles that have been emitted during a certain previous interval. According to this, at the end of any such interval we are looking at an entirely

* For the outline of this theory, see Vol. xlv, p. 188, of this Journal.

new tail. The particles may be supposed to be detached from the outer parts of the nebulosity by the sun's repulsive force, so called; in which case they would fly off in the directions of the lines diverging from the sun, along which the force acts, but would be made by the attraction of the nucleus to pursue paths somewhat, though doubtless slightly deviating from these lines, and concave towards the axis of the tail; or, we may imagine them, as Olbers and Bessel have done, to undergo some modification by the action of the sun, by reason of which they are first repelled outward from the nucleus, and then driven away from the sun into the depths of space by his superior repulsion. According to this view of the matter, they acquire an initial velocity in leaving the nucleus, and subsequently, under the action of the sun's repulsive force, supposed to vary according to the law of the inverse squares, they will move off in hyperbolas, having the sun in their remote focus, and concave towards the axis of the tail. This, or an equivalent fact, has been established by Olbers, and I find may be easily shown by introducing into the investigation of the ordinary case of central forces the modifications consequent upon the supposition that the two components of the accelerating force are positive instead of negative. These hyperbolic paths will be changed more or less by the continued repulsive action of the nucleus. Combined with these motions with respect to the nucleus, there will be the orbitual motion which each particle had at the instant of leaving the head, which will be retained afterwards. The effect of both these motions will be to make each particle describe a hyperbola having the sun in its remote focus. For, the particle may be conceived to start from a point of the orbit, or near the orbit, with an initial velocity equal and parallel to the velocity in the orbit, or equal to this modified in amount and direction by the repulsion of the nucleus, according as one or the other of the two views that have been given of the mode of disengagement of the particles be taken, and afterwards to be repelled by the sun. (I here regard the repulsive action of the nucleus as having no other effect than to impart a certain projectile velocity, in a moderate distance.) It is to be observed, too, that the motion with respect to the nucleus will be modified by the change in the direction and velocity of the nucleus subsequent to the escape of the particles. Also, if the two motions just mentioned be contemplated as subsisting

together, the motion relative to the head will obviously be somewhat different from what it otherwise would be, in consequence of the change of direction of the sun's force produced by the orbitual motion.

Making use of certain data mentioned in a former part of this article, I find that the sides of the tail of the recent comet diverged from each other on the third of March, as if they came from a point but little more than 100,000 miles from the head. The comet of 1744 presents a case of still greater divergence. If, therefore, the matter of which the tail is made up be supposed to be detached from the marginal parts of the nebulosity by the repulsive force of the sun, there must sometimes, if not always, be some cause in operation tending to increase the divergence of the sides of the tail due to the separation of the lines of direction of the force. This can apparently be found in a rotation of the head. The effect of such a rotation would be to make the particles revolve around the axis of the tail, at the same time that they are darting along in the direction of its length, and thus to recede continually from the axis; as there would be but a small quantity of matter within their orbits to oppose by its attraction the centrifugal force consequent upon the motion of revolution. But is there any evidence of a rotation? To this question I make answer, that in the first place, since all the other heavenly bodies, so far as known, have this species of motion, there is a fair presumption that the cometary bodies have it likewise. In the next place, certain observed changes in the relative position of the multiple tails of some comets, and of the sides of the single tail of others, have rendered it almost certain that the tails of some of these bodies had a rapid rotation about their axes. The comets of 1769, 1811, and 1825, may be cited as examples. A rotatory motion of Halley's comet at its last appearance in 1835, was inferred from the rapid changes noticed in the situation of certain luminous streams, in the form of circular sectors, seen to issue from the nucleus on the side towards the sun. The observations upon the recent comet made at the Cape of Good Hope, (see Amer. Almanac for 1844, p. 95,) would seem to indicate the existence of the same motion in the tail, or rather tails, of this comet also. To produce a revolution of the particles of the tail around the axis, it is not necessary that the head should rotate about the prolongation of

this line. Nor is it necessary that there should be a rotatory motion in the plane of the orbit, so as to keep the first equator constantly in the same situation with respect to the radius-vector. Any change in this situation would only alter the rate of revolution and consequently the degree of divergence of the sides of the tail, the laws of the variation of which are not known. Still, if such a motion be supposed to subsist, we have an explanation in the centrifugal force of the first mentioned rotation, (in case its axis lies nearly in the plane of the orbits,) of the fact of the cl r proximity of the nucleus to the nebulosity on the side towards the sun: and Bessel has, in point of fact, seen reason to infer its existence in the case of Halley's comet in 1835.*

As to the variation in the velocity with which a particle flows off into space, it is evident that the tendency of the force must be to make the velocity increase continually, but more rapidly at first than afterwards. It will be seen too, that, whether we suppose the nucleus to have a repulsion for the matter that is moving away from it or not, the variation of the velocity at any considerable distance must be mainly due to the repulsive power of the sun. But if it be a fact that the matter which enters into the constitution of the tail, is, for a considerable portion of the length uniformly distributed, as we have seen reason to suppose was the case, or very nearly the case with the comet of 1843, then the particles must soon attain to a maximum velocity, and continue afterwards to move on at the same rate. This might nearly happen in case of a very rapid reduction of the force; but the more probable conception would be that the limitation to the velocity was an effect of the resistance of an ether in space. Such a resistance would, however, afterwards diminish the velocity as the force decreased, (though in a less rapid ratio,) unless the density of the ether decreased at the same rate that the force did.

I conceive that the tail terminates, to us, when from the increase of its tenuity in consequence of the divergence of the sides and of the augmentation of the velocity of the flowing particles, (and from the increase in the distance from the sun, if this luminary is the source of the light of the comet,) its light becomes too feeble sensibly to affect our eyes. It augments in brightness

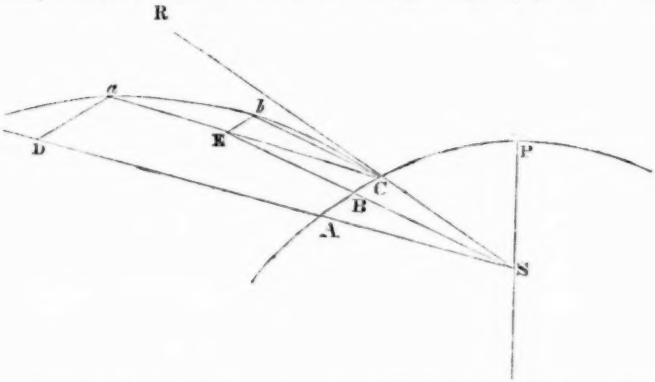
* See Vol. xlv, p. 206, of this Journal. The greater divergence of the sides of the tail than of the lines of direction of the sun's force, and the form of the nebulosity, are natural consequences of Olbers' theory of a repulsion from the nucleus.

and apparent length, when the supply of emitted matter is in greater quantities than before in a given time. Whether we suppose, with Herschel and others, that the materials of the tail are furnished by the heat of the sun, or, with Olbers and Bessel, that the particles of the tail flow directly from the nucleus, under the operation of a repulsion consequent upon some polarizing action of the sun, it must increase in apparent length and brightness as the comet approaches the sun. But it is supposable, on either theory, that the maximum action may not be till a certain time after the perihelion passage. The tail may also undergo variations of brightness and of length, as seen from the earth, by reason of changes in the obliquity under which it is viewed. Thus, the great brilliancy of the recent comet on the 28th of February, and its great length in the latter part of March, are partially attributable to the small angle of inclination of the line of sight to the line of the tail.

As to multiple tails they may originate in separate nebulosities, or may be collections of matter upon which the nucleus has different degrees of repulsive action. The fact often noticed, that multiple tails spring up suddenly and generally soon disappear, (of which we had an exemplification in the comet of 1843, as seen about the 3d of March,) may be alluded to here as affording striking evidence of the truth of the theory under consideration; for, it will be seen that their disappearance is a simple consequence of the waste of the local stock of materials which in the act of escaping had formed the supernumerary tail.

There is but little space left for the explanation of phenomena. Let us first see how the theoretical agrees with the actual situation of the tail. Let PCA be a portion of a comet's orbit, the sun being at S: and suppose a particle to be expelled in the direction SAD, when the head is at A, and another particle to be driven off in the direction SBE, when the head is at B. Each particle will retain the orbitual motion which obtained at the time of its departure, as it moves away from the sun; and thus, when the comet has reached the point C, instead of being at any points D and E on the lines SAD and SBE, will be respectively at certain points *a* and *b* farther forward. The line C*ab*, which when the comet is at C, is the locus of all the particles that have been emitted during the interval of time in which the comet has been moving over the arc AC, is the tail. It is easy to see that this

must be a curved line concave towards the regions of space which the comet has left. Supposing the arc AC to be so small, or its curvature to be so slight that it may be considered as a straight line, and neglecting the change of the velocity in the orbit, C*a* will be parallel to AD, and C*b* parallel to BE, whence RC*a*= CSA, and RC*b*=CSB. Thus the line joining any particle with



the nucleus always makes an angle with the prolongation of the radius-vector, equal to the motion in anomaly during the interval that has elapsed since the particle left the head. It follows from this that, if we suppose the velocity of the particles to be continually the same, and the motion in anomaly to be uniform, the deviations of the particles *a* and *b* from the line of the radius-vector will be in the ratio of the distances C*a* and C*b*. But in point of fact, the velocity increases with the distance, so that the curvature of the tail will be less than on the supposition just made: and, we may suppose, may after a certain time, come to be so great, compared with the velocity in the orbit, as to make the rest of the tail almost perfectly straight, as the greater part of it is sometimes observed to be. A curvature may afterwards spring up at the extremity in consequence of the nebulous matter being there more retarded by the resistance of the ether which is believed to pervade all space—this resistance having a greater effect than before, because of the diminution of the sun's force, and, perhaps, of a diminution in the density of the cometic matter itself. As to the amount of the deviation of the tail from the line of the radius-vector, it must depend upon the proportion between the velocities of the particles, and the velocity of the head in its orbit:

and it follows from the principle just established, that unless the velocities of emission augment as rapidly as the velocity of revolution, the deviation in question will increase to the perihelion and afterwards decrease; as it is in fact known to do. It appears therefore that the theory explains the general phenomenon of the situation of the tail.

We see also, in the light of this theory, why it is that the nebulosity is confined to the side of the nucleus that is turned towards the sun. All portions of nebulous matter that may at any time chance to be on the other side are soon expelled. As the sun does not act upon the farther side of the nucleus, there is probably little if any matter ever rising from that side.

The comparative indistinctness, sometimes noticed, of the following side of the tail may arise from the fact that the sun has acted during a shorter period of time upon that side of the nucleus.

I will only remark farther, that it is no objection to the theory which I have been advocating, that, if it be true, comets must be wasting away by reason of the continual escape of the matter of which they are composed, during each period of their approach to the sun. For observation has long since led astronomers to believe that such a waste is in actual progress. In fact there is nothing to forbid our supposing that the faint telescopic comet which steals through our firmament, almost unobserved, was once a very prince in the skies, and gloried in as long a train as did our illustrious celestial visitor of 1843.

ART. XV.—*Reply to Mr. Couthouy's Vindication against the charge of Plagiarism;* by JAMES D. DANA, Geologist of the United States Exploring Expedition.

WE cannot but regret that it has become necessary to intrude so unpleasant a controversy, as that before us, on public attention, and I should take my part in it with extreme reluctance, were it not urgently required, as well by the interests of science as of truth. If possible, I would now gladly drop the subject, especially because of its bearing upon Mr. Couthouy's character: but this may not be. No ill will towards Mr. Couthouy instigated the charge at Albany, but solely a regard for right; much of the

friendly feeling that sprung up while abroad, still lingered about me, and I couched my reclamation in as few words as possible—simple and courteous, but decided. The same course I shall still pursue in the remarks which follow; a plain and concise statement of facts will be sufficient I trust to set the subject at rest. Mr. Couthouy's paraphrase of my charge—which, by the way, merits a second reading, as a very explicit exposition of the crime of plagiarism—evinces sufficiently that he himself will appreciate the facts, thus stated, as fully as if expressed with vituperative language.

The public have cause for regret that Mr. C. did not bring forward at once the abstract of his journal sent home from Sydney, which is said to contain the views in dispute; as many words might possibly have been saved, if the facts are as stated; and it would have borne down with more force than all his dozen pages of argument. But for some reason this was kept behind. A few particulars respecting this abstract might be added here, but are better reserved until some personal accusations are disposed of.

Mr. Couthouy complains of unfairness in my not addressing him before making the charge public, and dwells upon the intimacy between us at sea, in order to bring out in bolder colors this "misused confidence." I acknowledge fully the "peculiar intimacy," and remember well the "warm expressions of regard" with which we parted when leaving the Sandwich Islands. I could bring farther evidence on this point if necessary, but will only desire the reader, before perusing the following remarks, to turn again to the last two pages of Mr. Couthouy's vindication. The confidence was mutual, evinced equally by each in endeavors to give aid in our several departments; and Mr. Couthouy never before, till his late Reply, accused me of failing to return his kindness—of giving him three or four dozen specimens for his three or four hundred—a fact (if we double the three or four dozen) it is true, but only so because Mr. C. was not with us at the Feejees to receive the contributions made by me to his departments, and left us for home at the Sandwich Islands before I had opportunity to return the kindness which he was enabled to bestow by his arrival at that group so long before they were reached by the squadron.* The *acknowledged* inti-

* Mr. Couthouy was with the squadron only about *one year and a half* of the *four* occupied in the cruise.

macy and confidence will set aside any imputation on my fidelity to him while abroad.

This intimacy and confidence continued, as he states, to the last. It led me, on arriving from the Feejees, to lay before him my Report alluded to, and my coral drawings, the latter including the coral animals of more than one hundred species. The Report, so strangely forgotten, extended over *seventy written pages*, and occupied us nearly *six hours* in reading. After presenting him all my ideas and showing him the drawings, I proposed, (in view of what I had done in this branch of science—the zoological part of which belonged rightly to him, and the geological to me,*) that we should unite our labors and bring out a report together on the whole subject of corals; and from the kindness with which the suggestion was received, I believed it to be a settled agreement between us. Soon after this, Mr. Couthouy was detached from the squadron, and, before finally separating, the proposition was again talked over, and the importance discussed of his making observations in the West Indies, towards the joint report. We parted "with warm expressions of regard."

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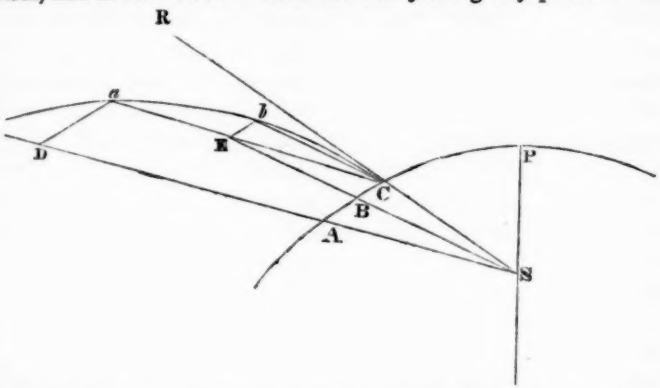
must be a curved line concave towards the regions of space which the comet has left. Supposing the arc AC to be so small, or its curvature to be so slight that it may be considered as a straight line, and neglecting the change of the velocity in the orbit, C*a* will be parallel to AD, and C*b* parallel to BE, whence RC*a*= CSA, and RC*b*=CSB. Thus the line joining any particle with



the nucleus always makes an angle with the prolongation of the radius-vector, equal to the motion in anomaly during the interval that has elapsed since the particle left the head. It follows from this that, if we suppose the velocity of the particles to be continually the same, and the motion in anomaly to be uniform, the deviations of the particles *a* and *b* from the line of the radius-vector will be in the ratio of the distances C*a* and C*b*. But in point of fact, the velocity increases with the distance, so that the curvature of the tail will be less than on the supposition just made: and, we may suppose, may after a certain time, come to be so great, compared with the velocity in the orbit, as to make the rest of the tail almost perfectly straight, as the greater part of it is sometimes observed to be. A curvature may afterwards spring up at the extremity in consequence of the nebulous matter being there more retarded by the resistance of the ether which is believed to pervade all space—this resistance having a greater effect than before, because of the diminution of the sun's force, and, perhaps, of a diminution in the density of the cometic matter itself. As to the amount of the deviation of the tail from the line of the radius-vector, it must depend upon the proportion between the velocities of the particles, and the velocity of the head in its orbit:

and it follows from the principle just established, that unless the velocities of emission augment as rapidly as the velocity of revolution, the deviation in question will increase to the perihelion and afterwards decrease; as it is in fact known to do. It appears therefore that the theory explains the general phenomenon of the situation of the tail.

We see also, in the light of this theory, why it is that the nebulosity is confined to the side of the nucleus that is turned towards the sun. All portions of nebulous matter that may at any time chance to be on the other side are soon expelled. As the sun does not act upon the farther side of the nucleus, there is probably little if any matter ever rising from that side.

The comparative indistinctness, sometimes noticed, of the following side of the tail may arise from the fact that the sun has acted during a shorter period of time upon that side of the nucleus.

I will only remark farther, that it is no objection to the theory which I have been advocating, that, if it be true, comets must be wasting away by reason of the continual escape of the matter of which they are composed, during each period of their approach to the sun. For observation has long since led astronomers to believe that such a waste is in actual progress. In fact there is nothing to forbid our supposing that the faint telescopic comet which steals through our firmament, almost unobserved, was once a very prince in the skies, and gloried in as long a train as did our illustrious celestial visitor of 1843.

ART. XV.—*Reply to Mr. Couthouy's Vindication against the charge of Plagiarism;* by JAMES D. DANA, Geologist of the United States Exploring Expedition.

WE cannot but regret that it has become necessary to intrude so unpleasant a controversy, as that before us, on public attention, and I should take my part in it with extreme reluctance, were it not urgently required, as well by the interests of science as of truth. If possible, I would now gladly drop the subject, especially because of its bearing upon Mr. Couthouy's character: but this may not be. No ill will towards Mr. Couthouy instigated the charge at Albany, but solely a regard for right; much of the

friendly feeling that sprung up while abroad, still lingered about me, and I couched my reclamation in as few words as possible—simple and courteous, but decided. The same course I shall still pursue in the remarks which follow; a plain and concise statement of facts will be sufficient I trust to set the subject at rest. Mr. Couthouy's paraphrase of my charge—which, by the way, merits a second reading, as a very explicit exposition of the crime of plagiarism—evinces sufficiently that he himself will appreciate the facts, thus stated, as fully as if expressed with vituperative language.

The public have cause for regret that Mr. C. did not bring forward at once the abstract of his journal sent home from Sydney, which is said to contain the views in dispute; as many words might possibly have been saved, if the facts are as stated; and it would have borne down with more force than all his dozen pages of argument. But for some reason this was kept behind. A few particulars respecting this abstract might be added here, but are better reserved until some personal accusations are disposed of.

Mr. Couthouy complains of unfairness in my not addressing him before making the charge public, and dwells upon the intimacy between us at sea, in order to bring out in bolder colors this "misused confidence." I acknowledge fully the "peculiar intimacy," and remember well the "warm expressions of regard" with which we parted when leaving the Sandwich Islands. I could bring farther evidence on this point if necessary, but will only desire the reader, before perusing the following remarks, to turn again to the last two pages of Mr. Couthouy's vindication. The confidence was mutual, evinced equally by each in endeavors to give aid in our several departments; and Mr. Couthouy never before, till his late Reply, accused me of failing to return his kindness—of giving him three or four dozen specimens for his three or four hundred—a fact (if we double the three or four dozen) it is true, but only so because Mr. C. was not with us at the Feejees to receive the contributions made by me to his departments, and left us for home at the Sandwich Islands before I had opportunity to return the kindness which he was enabled to bestow by his arrival at that group so long before they were reached by the squadron.* The *acknowledged* inti-

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This intimacy and confidence continued, as he states, to the last. It led me, on arriving from the Feejees, to lay before him my Report alluded to, and my coral drawings, the latter including the coral animals of more than one hundred species. The Report, so strangely forgotten, extended over *seventy written pages*, and occupied us nearly *six hours* in reading. After presenting him all my ideas and showing him the drawings, I proposed, (in view of what I had done in this branch of science—the zoological part of which belonged rightly to him, and the geological to me,*) that we should unite our labors and bring out a report together on the whole subject of corals; and from the kindness with which the suggestion was received, I believed it to be a settled agreement between us. Soon after this, Mr. Couthouy was detached from the squadron, and, before finally separating, the proposition was again talked over, and the importance discussed of his making observations in the West Indies, towards the joint report. We parted "with warm expressions of regard."

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him till the sheets of his article in the Boston Journal *were going through the press*. This fact was fully stated in my Report, the reading of which has been so singularly forgotten, and the whole explained at some length: yet he only *verified* it when, long afterwards, his paper was in the press.

But leaving this subject and others, I take up again the abstract of his journal sent home from Sydney. Respecting it he says, "that so far from my having derived the opinions in question, as Mr. D. alleges, from his MSS. at the Sandwich Islands in 1840, they had at that period been several months in the possession of my friends in the United States, having been communicated from Sydney, New South Wales, in substantially the same form as to facts, so far as the influence of temperature on corals is concerned, as that of their publication in January, 1842." After giving his reasons for this, he proceeds to say that the loss of his journals, subsequently proved his wisdom in adopting this course.—(Vol. XLV, pp. 380, 381, of this Journal.)

The *journals supposed to be lost are safe*. By permission from Judge Tappan, they were a few days since submitted to my inspection. Commencing with the date of our first appearance among the coral islands, Aug. 14, 1839, I have followed the journal through, day after day, page after page, till our arrival at Sydney: and what was contained in this original document of which the one at Boston is an abstract or duplicate minutes? A few remarks on the existence and structure of reefs, their forms and composition, and descriptions of a few species. *Not a word on the influence of temperature on the growth of corals*, nor any thing bearing the most remotely on this subject. Before commencing my examination, Capt. Wilkes, who has had the perusal of this with the other Expedition journals, assured me that I should find nothing—but I preferred to satisfy myself by actual examination, as it would better satisfy the readers of this Journal. The seals of his field note-books were broken for me, and these too contained nothing.

This reply to Mr. Couthouy I here close: and as I stated in the commencement, I say again most sincerely, that I could willingly withhold it from the public eye, would truth and honor permit. I should be glad now to draw my pen across the whole, if I could thereby spare one whom I have called a friend, without an unmerited sacrifice on my own part of character and right.

ART. XVI.—*Account of some new Infusorial Forms discovered in the Fossil Infusoria from Petersburg, Va., and Piscataway, Md.;* by Prof. J. W. BAILEY,—(with a plate.)

THE results of a hasty examination of specimens of fossil infusoria from Petersburg, Virginia, were given by me at the meeting of the Association of American Geologists and Naturalists in Albany, but more careful observations have led to the discovery of several new and interesting forms, and have made me better acquainted with the nature of others which had then been seen only in the fragmentary state. Many of these forms are, I believe, entirely unknown to naturalists, and as additional interest has been given to them, by the fact that several of them occur at the new locality just discovered by Prof. W. B. Rogers at Piscataway, Maryland, as well as at Petersburg, Virginia, I am induced to publish the following account, accompanied by sketches, which although they purport to be mere outlines, will yet serve to give a tolerably correct idea of these very curious and anomalous bodies. Among the most interesting of these bodies are the following.

1. *Podiscus Rogersi*, nob. (figs. 1 and 2, Plate III.) This is the most beautiful fossil animalcule which has ever been discovered. It undoubtedly belongs to the same genus as the curious living forms discovered by Ehrenberg in sea water, and very naturally named by him *Tripodiscus Germanicus*, as his specimens had but three foot-like projections. But as our species shows that *the number of feet may vary from three to seven*, I have ventured to change the generic name to *Podiscus*, and I trust that Ehrenberg will be willing to adopt so slight a modification of the name of this genus, the honor of the discovery of which belongs to him alone. As our species is the largest and most beautiful of the fossil infusoria occurring in the infusorial strata, of which Professor William B. Rogers of the University of Virginia made the truly splendid discovery, I have selected it as peculiarly appropriate to bear the name Podiscus *Rogersi*. The characters of this genus, as given by Ehrenberg, are as follows: "It belongs to the Bacillaria, section Naviculaceæ. Its members are free and possess a round bivalved siliceous lorica, having three [or more] appendiculated processes, and dividing by longitudinal

self-division." He appears to have seen no fossil species, as he describes none but the *P. Germanicus*, which he found alive in sea water at Cuxhaven. Our species may be thus characterized:

Podiscus Rogersi, (figs. 1 and 2.) *Lorica large, orbicular and compressed, having three to seven hyaline lateral processes placed on an elevated circle, within which the disc is slightly concave, and outside of which the surface is part of the frustum of a cone.* The whole surface is beautifully punctate, in a manner to which no engraving could do justice. The most complicated markings on the Coscinodisci scarcely rival the elaborate ornaments of this truly elegant creature. This species is quite common in the fossil state at Petersburg, Va. and also occurs at Piscataway, Md. Our figure is intended merely to show the general size, and the position of the feet. Fig. 1 shows a view of the disc, and fig. 2 is half of an individual seen edgewise.

2. *Zygoceros Tuomeyi*, nob. (figs. 3 to 9.) The remarkable form represented in outline by these figures, occurs both at Petersburg and at Piscataway. I am disposed to refer it to Ehrenberg's genus Zygoceros, which he describes as being "free, Navicula shaped, compressed and bivalved, each end provided with two perforated horns." The figures above referred to will give a better idea of the shape of our species than words will furnish, but the following is offered as an attempt to characterize it.

Zygoceros Tuomeyi. *Lorica having at each end two obtuse horns, with swollen bases, between which are one to three globular projections on each side; those in the middle being largest, and often bearing two spines.* At the base of each of the swellings the shell often shows perforations, (see *a*, *a*, *a*, figs. 3 and 4,) and the whole surface of the shell is covered with shagreen-like asperities. I dedicate this species to M. Tuomey, Esq., to whom I am indebted for fine specimens of infusorial and other fossils from the neighborhood of Petersburg. Fig. 3 shows a large and perfect individual; fig. 4, a smaller one; fig. 5, a young individual; fig. 6, one seen obliquely; fig. 7, an oblique view of one half; fig. 8, a top view; and fig. 9 shows two halves of different individuals united in the manner in which they probably formed chains when living.

3. *Zygoceros rhombus?* (figs. 10 and 11.) Our figure represents a species which so closely resembles the *Z. rhombus* of Ehrenberg, that I am inclined to consider it as most closely allied

to, if indeed it be not a variety of, that species. Ehrenberg thus describes *Z. rhombus:* "Large, lorica turgid, viewed laterally rhomboidal and having rounded angles, surface marked with very delicate striæ, the back having a smooth central zone." These characters apply pretty well to our species, with the exception that the central zone in ours is quite distinctly striated, with two sets of lines crossing each other at right angles. The shape of the horns is also somewhat different in our species from those shown in Ehrenberg's figure. The *Z. rhombus* was discovered by Ehrenberg alive in sea water at Cuxhaven; our species is very abundant in the *fossil* state at Petersburg, Va.

To the genus Zygoceros I now unhesitatingly refer the living species which I detected in Boston harbor, and which I described by the name of *Emersonia elegans.* I propose therefore to change this name to that of *Zygoceros Emersoni.* My *Emersonia antiqua* (fig. 25, Pl. II, of Bacillaria) is probably only the young state of *Z. rhombus?* abovementioned. The living species form zigzag chains.

4. *Triceratium spinosum,* nob. (fig. 12.) This large and very curious species of Triceratium occurs sparingly at Petersburg, Va. Its lorica is triquetrous, laterally slightly convex, with obtuse angles or horns, the surface marked with shagreen-like projections, and bearing four [or more?] large spines. Fossil with several other species of Triceratium at Petersburg. The figure shows the outline of half of an individual.

5. *Navicula? concentrica,* nob. I give this provisional name to the bodies represented in figures 13, 14 and 15. When seen laterally they show an elliptical figure, marked with concentric circular spaces, which when seen edgewise are found to bound a series of gradually diminishing step-like projections. Two individuals [?] probably resulting from spontaneous division, are usually found adhering. Fossil at Petersburg and Piscataway. Fig. 13 shows an edge view, fig. 14 the side, and fig. 15 an oblique view, with the end to the front.

6. *Dictyocha fibula?* (fig. 16.) This occurs in *vast* abundance among the fossil infusoria at Piscataway, Md. It differs from Ehrenberg's *D. fibula,* by generally having five instead of four cells in the convex rhomboid, but I am satisfied that the number of cells is a very variable character in this genus.

7. *Dictyocha aculeata?* (fig. 17.) Our figure represents a fossil species of Dictyocha from Piscataway, which perhaps belongs to Ehrenberg's species *D. aculeata*, for which he gives the following characters. "Cells arranged by sixes in the form of a ring, each cell being spiny within."

In figures 18, 19 and 20, are shown several other fossil species of Dictyocha from Petersburg and Piscataway; some of them are probably new.

In figure 21 is represented a fragment of a singular body, which was rounded or pyriform, with large perforations in its surface. Several fragments of similar bodies were found among the infusoria from Piscataway; and in Plate III, figs. 27 and 28, of my memoir on the Bacillaria, I have represented analogous bodies from Richmond. Their nature is unknown to me.

In figure 22 are shown small globular bodies, with projecting spines, which occur fossil at Piscataway. They resemble somewhat the curious siliceous spiculæ discovered by Bowerbank in the *Tethea lyncurium*.

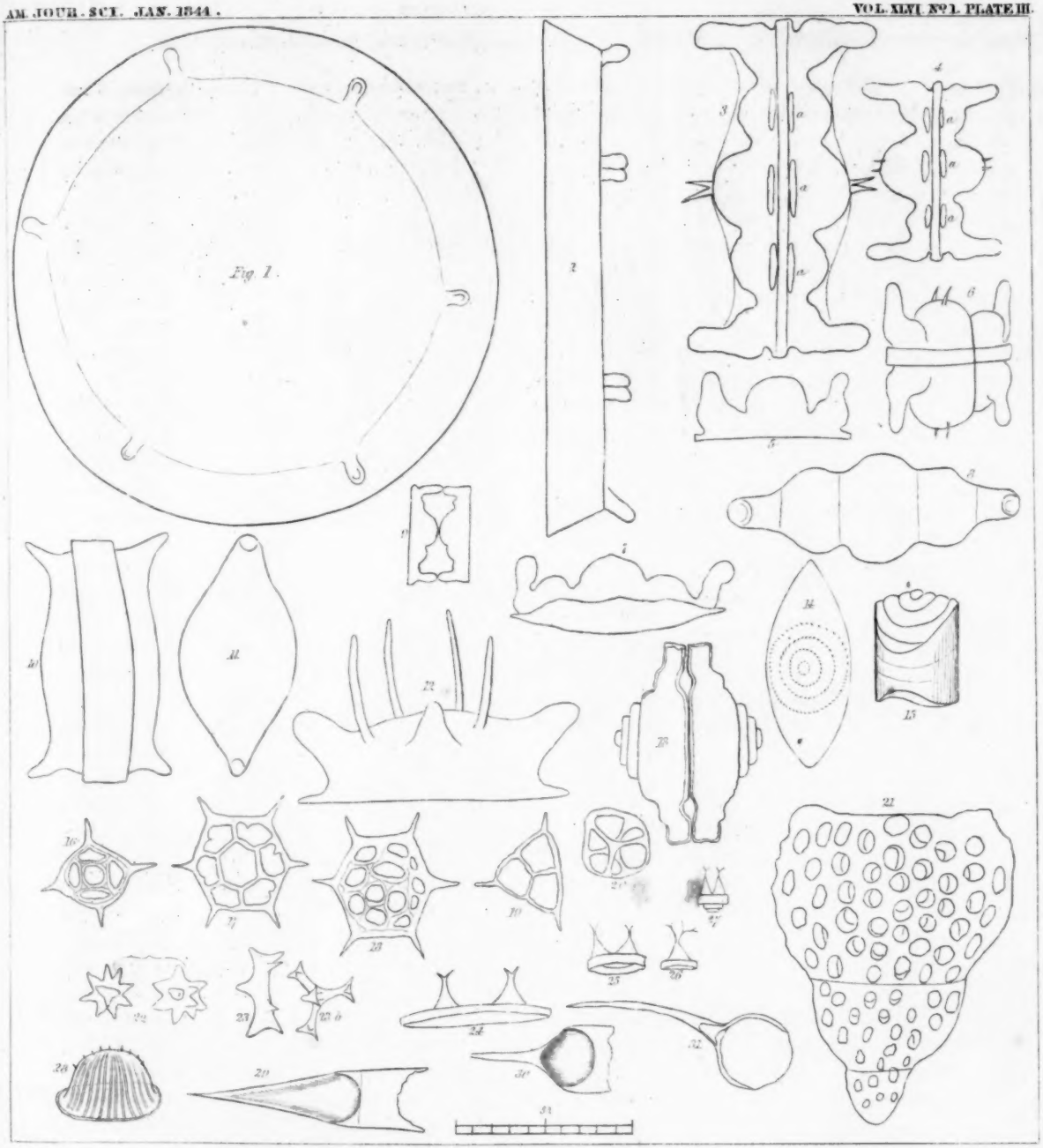
Figures 23 and 23*b*. show two other singular shaped spiculæ from Piscataway.

Figures 24 to 27 show anomalous bodies occurring fossil at Petersburg and Piscataway. They consist of an elliptical base, supporting one or two conical bodies which terminate in simple or branched projections.

Figure 28 appears to be half of a body allied to Coscinodiscus, but with radiating striæ instead of cells upon its surface. Fossil at Piscataway.

Figures 29, 30 and 31, represent hollow glass-like siliceous spines, not uncommon at Piscataway, but of whose nature I am ignorant.

None of our infusorial marls that I have yet examined contain any Polythalamia, but in the accompanying tertiary beds of shells, I have found numerous and highly interesting Polythalamian forms, which I propose to describe in a paper which I am preparing upon the American fossil Polythalamia. All the figures which accompany this paper were traced from nature by the aid of a camera lucida eye-piece, and are therefore correct as far as they go, but all the minute markings are omitted. The scale to which they are all drawn is shown in fig. 32, which



BAILEY'S FOSSIL INFUSORIA.

represents $\frac{1}{1000}$ths of a millimetre, magnified equally with the drawings.

West Point, Oct. 31, 1843.

Note.—I take an opportunity afforded while correcting the proof-sheet of the preceding article, to state that since it was written I have examined some sediment which I collected from a small creek, opening into the Atlantic ocean near Rockaway Pavilion, Long Island, and that among many interesting infusorial forms I had the pleasure of finding *recent* specimens of *Podiscus Rogersi*, having *four* foot-like processes. I also found that rare and beautiful form, *Biddulphia pulchella*, and was struck with its *generic* resemblance to the above-mentioned *Zygoceros Tuomeyi*. It is possible that the latter should be referred to the genus Biddulphia. Large and beautiful specimens of *Triceratium favus*, Ehr. occurred with the above, and I noticed also *Dictyocha fibula* and *D. speculum*, besides numerous species of Coscinodiscus and Actinocyclus. Small Polythalamia belonging to the genus Rotulia occurred with the above, thus giving upon our *sandy* sea-coast a mixture of infusorial and Polythalamian forms analogous to that which Ehrenberg has observed in some of the chalk marls of Europe and Africa. In examining mud from Boston harbor, I have recently detected portions of that truly beautiful infusorial form, *Isthmia obliquata*. For full descriptions of it, and of the above-mentioned *Biddulphia pulchella*, see a paper on British Diatomaceæ, by John Ralfs, Esq., in the Annals and Magazine of Natural History, Vol. XII, p. 271. A translation of Ehrenberg's paper, describing some of the interesting forms detected by him living in sea water, will be found in Taylor's Scientific Memoirs, Vol. III, Parts X and XI, accompanied by figures of *Podiscus Germanicus*, *Zygoceros rhombus*, *Triceratium favus*, and several other forms above referred to. J. W. B.

West Point, Dec. 5, 1843.

Extract from a letter by Prof. Wm. B. Rogers, to the Junior Editor, dated Richmond, Dec. 13, 1843.

Dear Sir—I regret that it is not in my power to furnish an account of the *tertiary infusorial formation of Maryland*, re-

cently discovered by me, in time for your forthcoming number. Ere long however, I hope to have that pleasure. In the mean time it may not be uninteresting to your readers to learn that this deposit spreads northwards beyond the Potomac, and is found in *Maryland*, forming at some localities, an important member of the tertiary series. The general aspect of the mass as seen near Piscataway, is like that of the principal Virginia localities, and its position is above but apparently near the base of the meiocene. On some of the fragments in my possession, are well preserved impressions of meiocene shells, among which I may mention *Astarte undulata* as particularly distinct.

Prof. Bailey, *our* Ehrenberg, having applied his skillful observation to a small portion of the material which I sent to him by letter, has confirmed my ruder determination as to the prevalence of various species of Coscinodiscus in the mass, and has besides recognized a variety of other interesting forms. Through his kind sanction, I annex a list of some of these curious and beautiful objects, referring to his own memoir and accompanying figures for a more detailed description.

Coscinodiscus argus; C. excentricus; C. lineatus; C. oculus-iridis; C. patina; C. radiatus, &c. *Actinocyclus senarius; A. bisenarius; A. quindenarius*, &c. *Podiscus Rogersi*, occurs sparingly. *Zygoceros Tuomeyi*, is not rare. *Gaillonella sulcata?* abundant. *Dictyocha fibula?* extremely abundant, far more so than at any other known locality. *Dictyocha speculum*, abundant. Several large and new? species of *Dictyocha;* several small species of *Navicula*, one of which is panduriform; besides many other new and interesting objects, of which Prof. B. will give an account in the continuation of his valuable memoirs on our infusorial fossils.

The extent to which the infusorial beds of the tertiary have thus far been traced, invests them with a far higher geological importance, than in my first observations I anticipated; and should they be found, as I believe they will, stretching northwards to the Delaware, and southwards far beyond the Roanoke, they will deserve to be regarded as a prominent portion of our great Atlantic tertiary series, and as one of the most striking objects in the geology of our great Atlantic plain.

Very truly your friend,

Wm. B. Rogers.

B. Silliman, Jr., Esq.

Art. XVII.—*Review of the New York Geological Reports.**

The geological survey of this vast state is at length completed, and the final Reports of the State geologists have passed through the press, with the exception of the volume on Palæontology. The zoological volume of this series has already fallen under our notice, (vid. ante, Vol. xlv, p. 397,) and the mineralogical division is also before our readers in the present number, (see p. 25.) Our present intention is to make a rapid survey of the general scope of the four volumes of purely geological matter which we have before us, comprising the labors in each of the four great original divisions of the state; while we reserve for the future, a review of the volume on palæontology by Mr. Hall, as well as any more particular mention of the individual reports now under consideration, which it may be desirable to make.

A word upon the mechanical execution of the work before entering on its details. The typography is large and tolerably clear, although a punctilious printer would, perhaps, think it sometimes "muddy." The wood-cuts are done generally very well and some of them are unexceptionable; so are some of the large fossils in lithograph, of which we would particularly notice plates 19 and 20 of Mr. Mather's volume, which are admirably managed. Many of the sectional plates, however, lack neatness, although doubtless sufficiently good for the object. An enumeration of the sections and plates, would be alike tedious and unprofitable. Separate from the volumes, is a geological chart three and a half feet by

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* Natural History of New York, Part IV. Geology, Part I, comprising the Geology of the First Geological District. By William W. Mather, Prof. Nat. Hist. in Ohio University. Albany, Carroll & Cook, 1843. 4to, pp. 706, illustrated with 46 colored sections, views and figures of fossils, and numerous wood-cuts. $4.

Natural History of New York, Part IV. Geology, Part II, comprising the Survey of the Second Geological District. By Ebenezer Emmons, M. D., Prof. Nat. Hist. in Williams College. Albany, W. & A. White and J. Visscher, 1842. 4to, pp. 437, with 17 plates of geological sections, fossils and views. $4.

Natural History of New York, Part IV. Geology, Part III, comprising the Survey of the Third Geological District. By Lardner Vanuxem. Albany, W. & A. White and J. Visscher, 1842. 4to, pp. 306, with 80 wood-cuts of fossils and sections. $4.

Natural History of New York, Part IV. Geology, Part IV, comprising the Geology of the Fourth Geological District. By James Hall. Albany, Carroll & Cook, 1843. 4to, with numerous plates and wood-cuts. $4.

three feet, colored so as to give a general view of the range, extent and bearings of all the principal formations of the state.

The readers of this Journal are doubtless aware that the geological survey of New York was conducted by four principal geologists. To each of these a certain district was assigned, and each made his own report in a separate volume. W. W. Mather surveyed and reported on the first district; E. Emmons on the second; L. Vanuxem on the third; J. Hall on the fourth. This division of labor undoubtedly brought the work more speedily to a close, and has probably given to the public a more minute, local geological knowledge, than could have been otherwise obtained; but as the districts were laid off before the number and extent of the geological formations were known, their boundaries are comprised within geographical rather than geological lines, and the final reports, in consequence, are not a little prolix, are voluminous and expensive, and do not give as clear and connected a view of the geological features of the State as could be wished. The same remark applies to descriptive county geology, which has been adopted in part, in the reports of the New York geologists. It is a good plan for the inhabitants of the State generally, inasmuch as they can refer easily to the remarks which apply to their own immediate vicinity; but it necessarily involves repetition, and gives but a disjointed and piecemeal view of the country to be described. We are of opinion that before this work can become generally useful and extensively circulated, it must be condensed and arranged into one compendious volume.

In proceeding with the review of the work before us, we shall divide it into two parts. In the first, we shall endeavor, by culling from the descriptions of all the four districts, to give a general outline of the geology of the State; in the second, which will appear in a future number of this Journal, we shall collect together some of the most important and interesting details. More than this would be beyond the objects we have in view.

If we except the superficial, unconsolidated, recent deposites, which occupy but a very limited area, all the rocks of the State of New York are older than the coal formation. They belong, either to the unstratified crystalline,—the primary of older writers,—the stratified non-fossiliferous, or to the older palæozoic strata, which latter terminate upwards with an outlier of a conglomerate, the lowest member of the coal formation, found on

the highest elevations, near the Pennsylvania line. The question, therefore, as to the existence of coal within the boundaries of the State, is at last fully settled, and a knowledge of this fact will be the means of preventing many from embarking capital and labor in fruitless attempts in search of this combustible. This is the more especially important, since there are bituminous shales amongst the New York strata, which are apt to mislead the unwary, and have already caused not a little disappointment to enterprising citizens. The absence of coal is a matter which the inhabitants have truly to deplore. Since, however, it exists in Pennsylvania, not far from the State line, and the means of transportation are daily increasing, New York can be easily and cheaply supplied from the inexhaustible stores of her neighboring State.

Primary system.—The non-fossiliferous rocks, both crystalline and stratified, are confined to an irregular, circular area, in the northeast, and a small triangular corner in the southeast, covering, in all, about one-third of the State. On the geological chart, they are all included in one color, a pink, and denominated "Primary system."

The prevailing rock in this system is gneiss. Granite exists, but it is unimportant, both as regards its extent and economical relations. The hypersthene, on the contrary, though long supposed not to be an American rock, was found by Dr. Emmons to occupy a triangular area extending over nearly the whole of Essex county, and to be traversed by valuable beds and veins of magnetic oxide of iron, probably in larger and more extensive masses than any in the United States.

Besides the above rocks, there exist in the northern primary region, primitive limestone, serpentine, Rensselaerite, hornblende, sienite, talc, or steatite, porphyry, and trap.

Of all these, the hypersthene rock and primary limestone are the most important, in an economical point of view; the former on account of the rich beds and veins of iron ore, the latter as affording materials for constructions and agriculture.

Taconic system.—On the extreme eastern boundary of the State, and extending into Vermont and Massachusetts, is a system of rocks lying locked in between the New England primary, on the east, and the lowest fossil-bearing rocks of New York, on the west. Dr. Emmons endeavors to show, that these rocks form

an isolated group, distinct from the primary, and yet not metamorphic palæozoic strata: he has given them the name of *Taconic system*, since they exist on both sides of a range of hills, known by the name of the Taconic mountains, running north and south, almost coincident with the eastern boundary line of the State. He admits that the slates and shales composing this system closely resemble the lowest fossiliferous schists; but endeavors to prove that they can not be these latter strata altered, because there is a want of similarity in the position of the rocks of the Taconic system and those fossil-bearing strata to which they are referred; "for," says he, "we do not expect that by any agent, a slate can be changed into a limestone, nor is it likely to be; neither will the order of superposition be changed by metamorphism." Admitting this, we do not consider the argument altogether conclusive, because, according to Dr. E., the Taconic series is of great thickness, and though, in its present upturned and contorted position, it occupies but a narrow belt, when spread out of course had a much greater superficial area: but equivalent beds, identified by their fossils at distant localities, may be sandstones or argillaceous deposites in one place, and a limestone in another. The Taconic rocks may have title, as Dr. E. contends, to be considered a distinct system, but fully to establish this, demands, we think, other and more decisive evidence.

Dr. E.'s arguments in proof that the strata under consideration are distinct from analogous primary beds, is founded on difference in texture, color, association, chemical composition and mineral contents. Comparing them, he remarks:

"Taking, for example, the talcous slates of the two systems, I have no hesitation in saying that constant and reliable differences exist, and may be found in all careful and close examinations. These differences exist in the quality of the slates themselves, particularly in the color and lustre of the laminæ, and their peculiar contortions. But more decided differences are found in the associations of the rocks. The talcous slate of the primary system is universally associated with hornblende or soapstone, or both; while the talcous slate of the Taconic system is never associated or connected with either of these rocks; or, to state the fact in other words, never passes into them, whereas, in the former case, it does. Another fact of the same nature is also well determined by observation, viz. that the imbedded minerals be-

longing to each rock are remarkably distinct. Actinolite, epidote, titanium, auriferous sulphuret of iron, &c., are never found in the Taconic system.

"This brings us to the conclusion, then, that where the associate minerals are different, the rocks themselves are different; and there are so few exceptions to this statement, that it appears to the writer to furnish sufficient grounds for separating one system from the other, by the aid of characters sufficiently important and decisive for all the purposes of geology.

"I have confined my remarks to the differences in the slates. Equally important are they, when we compare the limestones of the other systems with those of the Taconic. While the texture and grain of the limestones of the two systems differ, there are still more distinctive and specific marks which may be employed. The presence of graphite in the limestones of the primary system, may always be depended upon, even in hand specimens; for not an instance has occurred in which this substance has appeared in the limestone of the Taconic system, or in an aqueous deposite. Besides, the instances are not very numerous in which any minerals of the primary rocks are found in this system. White pyroxene and tremolite do occur at a few localities; but the peculiar constitution of graphite makes it very doubtful whether it is ever produced in rocks of aqueous origin, except where they have been subject to the powerful action of melted lavas, or to the influence of caloric in some other mode. Molecular action, unaided by heat, is insufficient to effect the decomposition of carbonate of lime, so far as the development of carbon from carbonic acid is concerned; and then its combination with metallic iron to complete the chemical constitution of this substance, appears to be still more difficult. Wherever graphite exists, we may rest satisfied with the conclusion, that the agency of caloric has been there, and in a state, too, of great intensity.

"If, then, reliance can be placed upon lithological characters, and upon associate minerals, we may raise something more than doubt as it regards the identity of the Taconic rocks with the true primary system, or certain members of it. In truth, such confidence is felt in the correctness of the principles which have influenced me in proposing their separation, and that they possess characters fully sufficient to give them an independent place in the systems of the day."

This test of the origin and geological position of a limestone, by the presence of *graphite*, does not seem to be so conclusive in all parts of the United States as it would seem to be in New York. Professor H. D. Rogers, in his report on New Jersey, describes a locality, four miles southwest of Sparta, in that state, where there is a belt of limestone containing graphite, which he considers as belonging to formation II, i. e. the equivalent of the Black River and Trenton limestones of New York, but altered by the vicinity of a granitic dyke. Speaking of this locality on p. 73 of the New Jersey report, Prof. Rogers remarks:—

"Immediately upon the western side of this curious vein, and ranging along the base of the hill, occurs the narrow belt of altered limestone. The gradation of change which here exists between the blue and earthy limestone, and the white crystalline rhombic spar, is distinctly traceable as we approach the igneous dyke. In a breadth not exceeding fifty feet, we discover every degree of modification which the rock can undergo by heat. The first intimation which the limestone gives us of its having been subject to the igneous agency, is its passage from the ordinary earthy texture to a sub-crystalline one.

"We next behold a slight change of color to a lighter tint of blue, and at this stage of alteration, we notice the first development of the *graphite*, as yet seen only in small, but very brilliant scales, which are oftentimes hexagonal. Very soon the mass becomes mottled with white, minutely granular carbonate of lime, the spangles of graphite growing progressively larger. Approaching still nearer to the dyke, the whole rock assumes the white sparry character, and contains near the line of contact, besides the graphite, several of the numerous crystalline minerals of the vein itself. So completely has the injected matter of the vein been mingled, in many places with the fused substance of the limestone, that no distinct line of demarcation is discernible between them." And on p. 74 he goes on to say: "The invariable occurrence of *graphite* in portions of the altered belt *remotest* from the dyke, and its never existing in more than a very trivial quantity, even adjacent to the vein where the other extraneous minerals are frequently present in great excess, strongly imply that it has been derived from the elements of the blue limestone itself, which may easily be proved to contain an adequate quantity of iron and carbon for the production of this mineral."

Here, then, appears to be an unequivocal instance of the existence of *graphite* in an altered protozoic limestone of aqueous origin; and the graphite is in greatest abundance, not in the immediate vicinity of the dyke, where the heat must have been most intense, as we should expect from the inferences of Prof. Emmons, but in the altered parts of the limestone more remote from the centre of igneous action.

The Taconic rocks are supposed by Dr. E. to be the equivalent of the lower Cambrian of Prof. Sedgwick. It will appear however, in the following extracts from Mr. Murchison's address, delivered at the anniversary meeting of the Geological Society of London, February 17th, 1843, that the Cambrian formation is now no longer recognized as a distinct system. Speaking of the palæozoic rocks of the British isles, we find on pages 16 and 17, the following remarks:—"Prof. Sedgwick has reassured himself that there are fossiliferous slaty masses of great vertical thickness, which rise out from beneath lowest Silurian rocks of North Wales hitherto described, and occupying the region of Merionethshire and Snowdon, alternately rest upon chloritic and micaceous schists (Menai Straits), into which they do not pass. The lowest of these fossil bands, forming the summits and flanks of Mod Hebog and Snowdonia are, he conceives, several thousand feet below the Bala limestone.

"The hope, however, which was entertained by my friend of finding these vastly expanded and lower members characterized by peculiar groups of fossils, has been frustrated, and whatever may be the thickness of this lowest palæozoic division, in which he has collected a great number of species, he now fully admits, that zoologically it is from top to bottom, a lower Silurian series. Charged as it is with characteristic Orthidæ and trilobites, including the Asaphus tyrannus, so characteristic of the lowest Silurian rock, there are, as may be expected, a few new and undescribed species: and, among these, an Ophiura will not appear the least extraordinary.

"The base of the palæozoic deposites, as founded on the distinction of organic remains, may now, therefore, be considered to be firmly established; for the lower Silurian type is thus shown by Prof. Sedgwick himself to be the oldest which can be detected in North Wales, the country of all others in Europe, in which there is a great development of the inferior strata."

It is evident from the above passages, that the most recent observations in England now recognize no system between the crystalline schists or primary stratified, and the true Silurian system. The Taconic rocks must, therefore, be the equivalent either of the lower Silurian, of Wales, or else must be a series wanting in England; in that case, they may form a new system.

The rocks which compose the Taconic system are few in number, viz. granular quartz, slate, and limestone, repeated thus in the ascending order: Stockbridge limestone, granular quartz, magnesian slate, sparry limestone, Taconic slate. There are, therefore, two kinds of limestone, and two kinds of slate.

The most important economical products of this system, are the white and clouded marbles, furnished by the calcareous beds; the hematitic iron or limonite, derived from the decomposition of the slates and slaty limestones, the white siliceous sand, for glass and sand paper, and for sawing marble; procured from the granular quartz.

The absence of trap dykes in this system is remarkable. Prof. Emmons has never yet seen an instance of any description of injected rocks associated with the Taconic beds, and he infers that very few disturbances have occurred since the general uplift of the country.

New York system.—It is the older palæozoic rocks, or protozoic, of Murchison, that form the characteristic geological features of the State of New York. They occupy all the country lying between lakes Ontario and Erie, and the Pennsylvania line; also, the greater part of the tract situated south of the primary region; i. e. south of a curved line running along Black river, down the valley of the Mohawk to Johnstown, thence along the meanderings of the Sacandago river to near Glen's Falls; thence nearly northeast, to the south end of lake Champlain; besides a semicircular belt lying north of the primary region, and between it and the river St. Lawrence and Canadian line; in all, covering at least two thirds of the entire State.

Under the name of New York system, Dr. Emmons includes all the oldest fossiliferous rocks, up to the sandstones of the Catskill mountains. Mr. Vanuxem includes these in the system, and extends it to the conglomerates of the coal formation. Mr. Hall, on the contrary, excludes from the system, not only the sandstones of the Catskill mountains, but also the slaty sandstones

and shales in the southern part of the State, known as the Chemung group; and considers them both as belonging to the Old Red or Devonian system. And, in truth, it is matter of doubt which is the correct hypothesis; as we shall see when we come, by and by, to sum up the evidence derived from organic contents, lithological character and superposition.

No region ever yet explored, presents these protozoic strata, as the New York geologists aver, in so extensive, undisturbed development, as their State; and no country seems to afford such fine natural sections suited for the study and classification of rocks of this age. It is for this reason, that the New York geologists, following Dr. Emmons' recommendation, have adopted the term "*New York system.*" If a local nomenclature be admissible, no country can be better entitled to transfer its name to a geological system. We object, however, to local terms, except as provisional, because they are not generally applicable, and because they multiply synonymes, and render the geological vocabulary unnecessarily complicated.

No system of nomenclature is, in our view truly worthy of adoption, but one that is universally applicable to every region of the earth; pointing directly to the place in the chronological scale, which the formation designated occupies.

The total thickness of the New York system is between seven and eight thousand feet. According to Dr. Emmons' classification, the system in question consists of four principal divisions, named from the districts where they are in greatest force and best characterized. In the ascending order, they are as follows: *Champlain division*, *Ontario division*, *Helderberg division*, and *Erie division*.

The area which each of these occupies in New York is as follows:

The first division encircles the primary; and its upper strata extend from the union of the Hudson and Sacandago rivers, south down the valley of the Hudson, occupying the country between the eastern State line and the Helderberg range of mountains. The whole region comprising this division in New York forms a figure resembling the written letter *g*.

The Ontario division ranges along a belt of country running east and west, parallel with the southern shore of the lake of that name, nearly of uniform width, being the distance between

lake Ontario and the northeast corner of lake Erie; except near its eastern termination, where it first expands between the eastern shore of lake Ontario and Fish Creek, and then inclining a little southerly, rapidly tapers off to a point, and vanishes near Schoharie.

South of the latter, and parallel to it, is the Helderberg division, occupying a narrower but longer strip of country; for near Schoharie, it sweeps off in a curved line towards the south, along the Helderberg range, parallel with the Hudson river, as far down as Kingston, and thence southwest to the great bend of the Delaware, where the Jersey's northern State line strikes that stream.

The fourth, or Erie division, has a superficial area about equal to that of the other three put together. Running west and east, it stretches nearly across the State, covering the country between the Pennsylvania line and the south boundary of the Helderberg division; i. e. the southern third of the State of New York.

In the eastern portion of this tract, the Erie division is covered by the sandstones of the Catskill.

Each of the four divisions embraces the following rocks, beginning with the lowest:

Champlain division.—Potsdam sandstone, calciferous sandrock, Chazy and birdseye limestone, marble of Isle La Motte, Trenton limestone, Utica slate, Loraine shales, grey sandstone, conglomerate.

Ontario division.—Medina sandstone, green shales, and oölitic iron ore, Niagara limestone, red shale, Onondaga salt and plaster rocks, Manlius water-lime.

Helderberg division.—Pentamerus limestone, Delthyris shale limestone, Oriskany sandstone, Encrinital limestone, Caudigalli grit, Schoharie grit, Helderberg limestone.

Erie division.—Marcellus and Hamilton shales, Tully limestone, Genesee slate, Ithaca and Chemung shales and grits.

Without at present attempting a detailed description of the individual members, let us review them as a whole.

The lithological character of the Champlain group is siliceous at the base; gradually acquiring calcareous matter as it increases in thickness, it becomes a pure limestone rock; then we have an intermixture of argillaceous sediment, which increases in quantity, until the calcareous particles give place to a dark colored clay or mud, in the form of shale; the argillaceous beds

then become by degrees siliceous, and finally, a siliceous deposite, nearly pure, takes their place. Here we have an interesting example of a series of changes in the transported sediment during the period of deposition of this division; yet, at the same time, so imperceptible is the blending of adjacent strata, that it carries with it the conviction that no link in the chain is wanting; that nature has been permitted in that region, quietly and without interruption, during a long period of time, to do her work.

The Potsdam sandstone, the base of this group, is the oldest fossiliferous rock yet known in the United States.

It is in the middle portion of the Champlain division that the family of trilobites first appears, and there, also, are they most abundant. The genera *Isotelus*, *Cryptolithus*, *Calymene*, *Illænus*, *Bumastus*, *Ceraurus*, are mostly confined to it. The so called *Fucoides demissus*, now supposed to be a coralline, belongs exclusively to the early part of this division. That curious fossil, the *Graptolite*, is peculiar to these rocks. The greater number of species belonging to the genera *Leptæna*, *Orthis*, *Atrypa*, *Delthyris*, *Cypricardites*, are found in the Champlain division.

The western equivalents of the Champlain division, seem to be the magnesian limestones and sandstones between the mouth of the Wisconsin river and the falls of St. Anthony; and the lowest limestones of the Ohio valley, i. e. the blue limestones and marls of the reports on Ohio and Indiana.

From a comparison of the fossils of this division with those of Great Britain, Dr. Emmons is of opinion that its English representatives are the Bala limestone and the lower Silurian.

The Ontario division is composed of reddish sandstone and fossiliferous shales below; limestones and calcareous shales in the middle portion; red shales, gypseous shales, platerstone and water limestone in its upper part. The fossils of this group are, on the whole, not so abundant and remarkable as those of the preceding group. Two peculiar species of *Fucoides* belong to it; also, disk-shaped and pentangular *entrochites*, *tentaculites;* the genera *Littorina*, *Cytherina*, *Avicula*, a species of *Atrypa*, and *Orthis*, a *Lingula*, a *Strophomena*, *Asaphus*, and portions of two peculiar species of trilobites, to which the generic names of *Hemicrypturus* and *Eurypterus* have been given. Also, a new genus of Crinoidea, called *Cariocrinus*.

In an economical point of view, this is probably the most important division in the New York system, as furnishing all the plaster, water-lime, and salt water of the State of New York; besides, it affords fine beds of oolitic and fossiliferous iron ores, similar to that in Pennsylvania, which supplies much of the Juniata iron.

The most remarkable fossils in the Erie rocks are *Goneatites*, *Orbiculas*, the curtain and retort-shaped *Fucoides;* several species of *Delthyris* with the hinge very much produced; some species of *Atrypa* and *Orthis*, more or less of an orbicular form; some peculiar *Cypricardites*, *Avicula*, *Orthonata*, *Strophomena*, *Orthocera;* a trilobite which has received the generic name *Dipleura;* but the crustaceans seem to have been rare during the deposition of these strata. Here we find the first vestiges of land plants in the New York system; the *Goneatites*, too, have not been found as yet any lower in the series.

Interspersed in the bituminous shale at the base of this group, some partial patches of coal occasionally occur; but all the numerous explorations in search of a regular seam in the vicinity of these rocks, have ended in disappointment. The fact is, these beds lie many hundred feet below the base of the true coal measures, and were deposited long previous to the period when the circumstances favorable to the formation of coal existed. It does not appear that this division has yielded any valuable minerals: some of its members afford, however, some tolerably good building materials.

The representatives of the rocks of this group in the west, are the black slate and fine sandstones of Scioto, in Ohio, of the knobby region in Indiana and Kentucky, and the southwest part of Illinois, and the strata in the high ground of middle Tennessee, and the iron region of the same district.

The lower and upper beds of this group, appear to be absent in the West, but some of the middle beds have been identified.

If the specific determination of fossils is to be depended upon, the inference seems to be that the lower part of the upper Silurian system of England, represents the middle beds of the Ontario division of New York.

The Helderberg division is chiefly calcareous; limestone and shaly limestone below, sandstone and grit in the middle, and limestone above. The most remarkable fossil genera in these

strata, are *Pentamerus*, *Euomphalus*, *Hipparionix*, a fucoid, in the form of a cock's tail; a trilobite with a forked tail, *Odontocephalus; Cyrtoceras;* several species of *Strophomena*, *Orthis*, *Atrypa* and *Delthyris;* a variety of corals; some fossils considered to be defensive fin-bones of fishes; *Asaphus*, *Ascidapsis*, *Acanthaloma*, *Dicranurus*.

It does not appear that the Helderberg rocks have afforded any valuable materials, except such as are employed in constructions and agriculture.

Some of the fossils of this group bear a striking analogy, if they be not identical with a few of those which occur in the upper Silurian rocks of Murchison, and there is, perhaps, little doubt but they are cotemporaneous deposites.

The lithological character of the Erie division, as a whole, is argillaceous, viz. black and blue shales at the base, with intercalated thin beds of impure limestones in the middle, and shale and grits above.

The upper part of the Erie division passes by almost imperceptible gradations into the Catskill group, which is considered by Mr. Vanuxem to be equivalent to the old red sandstone of England.

It consists of light colored, greenish-gray sandstone, usually hard; a fine-grained red sandstone, red shale or slate; of grindstone grit; and a peculiar concretionary and fragmentary mass, like the *cornstone* of the old red sandstone of England.

The group in question is rather barren in fossils. Two species of Cypricardites have been found peculiar to it; also, some remains of a remarkable fish, considered the same as the *Holopticus* of the Devonian system of England. Fossil plants are more common in the Catskill group than shells or bones, giving rise sometimes to coal, accompanied by pyrites, but they never exceed one foot in length and breadth, and one inch in thickness. Until the position and age of this rock was determined, strong hopes were entertained that valuable seams would be discovered. "Instances are but too frequent where explorations have been undertaken," says Mr. Vanuxem, "which have been attended with much anxiety of mind, and have resulted in nothing better than a waste of time and loss of money."

The flora of the Catskill group shows an approximation or transition to the true carboniferous era. Amongst those of uncommon form, we recognize some of the familiar family of Sigillaria, so abundant in the coal measures.

In the extreme southern portion of New York, a few outliers of a conglomerate appear, the same which is developed in the adjoining districts of Pennsylvania, and forms the base of the adjacent coal formation, and considered the equivalent of the millstone grit of England.

No traces, however, of any limestone exist between this conglomerate and the Catskill group, occupying the position of that limestone which is so important and remarkable a member of the carboniferous system in Virginia and most of the western States, characterized by the Pentremite and Archimedes, often oolitic in its upper portion, and now universally admitted as the American representative of the mountain limestone of Europe.

Mr. Mather remarks, (p. 294,) "Prof. Hitchcock was considered years ago, as having almost demonstrated the equivalency of the red sandstone of the Connecticut valley, to the *new red sandstone.* There can be scarcely a doubt, that the sandstone east of the Blue Ridge and Highlands; that of the Connecticut and of the Housatonic valleys; and doubtless those of lake Superior, the Rocky mountains, and Nova Scotia, are identical in age, as they are in their general characters and in their associated rocks and minerals, and in their fossils, so far as we know."

We have spoken now in general terms of all the great geological formations of the State, up to the base of the coal formations. It remains only, for the present, to make a few remarks on the recent partial deposites.

Dr. Emmons describes these under the head of tertiary, though he considers them as belonging strictly to the post tertiary, of Lyell. Two thirds of these deposites consists of stiff blue clay, destitute of shells below; the rest is a yellowish sand, with an intervening mixture of sand and clay. It is in this mixture only that shells have been found. The genera are: *Myas*, *Pectens*, *Tellinas*, *Saxicavas*, and *Terebratulas*, in a state of wonderful preservation, showing that the deposite took place quietly and without interruption. The upper fossiliferous portion seems, however, to have been to a great extent swept away, as it is found only in sheltered situations. The principal localities of these recent deposites are the great valleys and basins of the eastern and northern parts of the State.

To sum up, then, in a few words, the remarks in the foregoing pages: The geological formations of the State of New York

belong chiefly to the older fossiliferous rocks below the coal measures. Granite is rare, but the gneiss and mica slate system is well developed and occupies a considerable area in the northeast. The carboniferous system is absent. The new red sandstone system is very partially developed in the southeast. The oolitic and cretaceous systems are entirely wanting. So also is the tertiary, according to the usual acceptation of the term.

ART. XVIII.—*The Variation and Dip of the Magnetic Needle at Nantucket, Mass.;* by WILLIAM MITCHELL.

I AM not aware that the dip of the magnetic needle at Nantucket has ever been published; nor am I aware that this element or that of the variation, has, till recently, been obtained in a manner having claim to accuracy; yet a glance at the map of the American coast, shows it, at once, to be an important magnetic position. In the year 1834, I obtained the variation of the needle by a series of observations of the sun's rising and setting amplitude, and also of his azimuth at equal altitudes before and after noon, and the result was 8° 27′ westerly. During the years 1837 and '8, it was repeatedly obtained, and near the close of the latter, stood at 9° 02′ 19″. In the summer of 1842, I established a meridian line on an open plain with stations fourteen hundred feet asunder, and remote from all visible local magnetic influences, and, with a long delicately formed needle, carefully suspended, made a great number of observations, principally during the months of August and September, the means of which showed a variation of 9° 9′. The amount of variation for the month of September, 1843, was obtained by the following method, which though far more laborious, is, when performed with care, decidedly the most satisfactory. From each station of the meridian line, the direction of the needle was referred by means of sight vanes, to a movable mark equidistant with the opposite station of the meridian, and the angle thus indicated by each settled position of the needle, was carefully measured with a sextant, properly adjusted, allowance being in each case made for the parallax of the instrument. An equal number of observations was made before and after noon at each station, and the mean of all, viz. 9° 09′ 59″,

may I think, be deemed a close approximation to the truth. On comparing the result last obtained with those of former observations, it is evident, that the westerly variation, which has been for years increasing, is still advancing, though at a diminished rate.

The inclination, or magnetic dip, was obtained by numerous observations between the 20th of September and the 10th of November of the same year. Those of the latter month were made at various localities within the compass of a mile, a condition which proved of importance. The instrument employed was one made by Gambey, furnished with two needles, manifestly a good article. An equal number of observations was made before and after the noon of each day; an equal number in each period with each needle; an equal number of the observations was taken with the instrument facing east and west, and an equal number with the poles of the needles reversed. The readings consisted of the mean of both ends of the needles, and the result of all, indicated a dip of 73° 41′.25.

How far the means employed in obtaining these elements, will entitle these results to confidence, is for those interested in the subject to judge; in the practical details, neither care nor labor has been spared.

Nantucket, Nov. 11, 1843.

ART. XIX.—*Re-examination of Microlite and Pyrochlore;* by AUGUSTUS A. HAYES.

THE July number, for 1842, (Vol. XLIII, p. 33,) of this Journal, contains a short paper, by Mr. J. E. Teschemacher and myself, on the identity of microlite and pyrochlore. In the same number, (p. 116,) Prof. Shepard has published an article entitled, "Want of identity between Microlite and Pyrochlore." Mr. Teschemacher, from studying the crystals of these minerals, arrived at the conclusion that they are of the same species. Prof. Shepard has, in detail, given his objections to the conclusions of Mr. T. As Mr. T. has seen nothing in the reply of Prof. S. leading him to doubt the correctness of his statements, he declined noticing the article. It is not my intention to offer any remarks on that part of Prof. Shepard's paper which contains his objections on "natural history grounds."

I shall also leave those "rules," which separate the microlite from pyrochlore, and place it with *yttro-tantalite*, their full influence. The kindness of Mr. Teschemacher and Mr. F. Alger, has enabled me to review my experiments on the microlite, and by placing in my hands fine crystals of both microlite and pyrochlore, laid me under obligation to communicate any additional information my results might afford.

I gave the pyrognostic characters of microlite, which are distinctive for the species, in the paper published by Mr. Teschemacher. They correspond to those of pyrochlore, so far as they were known to me. Pyrochlore was considered as a titanate of lime, with other oxides crystallized together. Besides the correspondence exhibited with fused reagents, I ascertained that the microlite was *soluble in hydrochloric acid.* The solution nearly neutralized by an alkali, gave to shavings of gall-nut *a red brown color.* When the acid solution was enclosed in a tube, with a bit of metallic zinc, a *bluish purple color was produced.* The analysis of one grain was made as an addition to the chemical characters. Some months after I made this examination, I saw for the first time Prof. Shepard's paper, (Vol. xxxii, p. 338, of this Journal,) giving a "chemical examination of microlite," and was not before acquainted with the fact, that the statement of its composition, given on the authority of Prof. S., as an ore of cerium, had been corrected. By the "examination" referred to, the evidence that columbic, instead of titanic acid, is the electro-positive constituent of microlite, I consider conclusive. I therefore most freely retract the opinion I expressed in relation to this point, and shall show how I was led into the error.

Analysis of the Microlite, from Chesterfield, Mass.

Regular crystals of the microlite were broken into fragments; of the parcel, about one fragment in twenty-five had a yellow color;* the residue presented shades of brown. Diluted hydrochloric acid was warmed on the fragments, to remove any adhering minerals. No lime or uranium was dissolved, but a little peroxide of iron was contained in the solution. After washing the fragments

* Mr. Teschemacher has called my attention to some minute, transparent, yellow, and highly brilliant crystals, which, with columbite and microlite, are found in the Chesterfield granite. They have the characters of a columbate, but differ in form from microlite. Mr. T. has a crystal of microlite, much modified by an uranium mineral, crystallized with it. Generally the yellow stains on the albite are the most marked indications of the existence of microlite crystals.

in water, they were dried on paper. Weighed at 60° F., 10 grains lost in pure water at that temperature 1·850, which gives 5·405 as the sp. gr. of the specimen.

The fragments were reduced to a fine powder, in an agate mortar, and dried over sulphuric acid, at about 60° F. A platina capsule, which had been recently ignited and cooled, contained 10 grains of the powder. After exposure to a bright red heat for twenty minutes, and cooled to 60° over sulphuric acid, the loss was 0·040. Exposed on the balance twelve hours, nearly the original weight was found, from absorption of atmospheric vapors. The microlite is therefore anhydrous.

A. Ten grains of the mineral, in fine powder, had been ignited, and were mixed with 200 grains of pure bisulphate of potash, in a large platina crucible. Heated to moderate redness, the powder dissolved into a yellow clear fluid. After cooling the crucible, water was added, and the whole again heated; the clear fluid resulting from the use of successive portions of water, being passed through a prepared filter. The white powder which remained was boiled in diluted hydrochloric acid, successive quantities being used and passed through the filter. Boiling water left undissolved a lighter, flocculent powder, which was collected on the filter. When sulphydrate of ammonia was added to this powder, it rendered it dark colored, and finally black. Twelve hours after, the sulphydric solution was removed, and the powder washed in water. Hydrochloric acid rendered the powder nearly white, and boiling water removed all traces of acid. After a copious washing in water, the powder has a slight degree of solubility. The filter and contents, dried, were heated red hot, cooled over sulphuric acid to 60°. 7·900 of pure dry columbic acid remained after deducting 0·004 ashes, left by filter.

B. After all the acid liquors, from the columbic acid, had been boiled, and their bulk greatly reduced by evaporation from a flask, the sulphuretted solutions from the same were added, drop by drop, so as to saturate the warm acid fluid with hydrosulphuric acid. A slight white precipitate had appeared during the boiling, it became darker colored, and was increased in bulk by a deposite of sulphur. When the odor of hydrosulphuric acid had been dissipated, the brown precipitate was separated from the clear fluid, washed in water, and collected and dried. By heat, sulphur was burnt off, and the addition of nitric acid, and subsequent ignition, left a white, heavy powder, weighing 0·200.

C. To the transparent acid fluid, a few grains of chlorate of potash were added, and the whole was heated. Chlorine gas escaped, and after the liquor became cold, ammonia was added to render it neutral. An excess of the same alkali was added, and the vessel closed; a yellow hydrous precipitate subsided, becoming flocculent. The clear fluid was passed through a filter, under a bell blass, containing hydrate of lime, and the yellow precipitate was collected on a filter, and carefully washed in water containing muriate of ammonia. Diluted nitric acid redissolved the yellowish brown precipitate, leaving on the filter a mere trace of a white powder, which was added to that of B. The nitric solution was rendered nearly neutral by carbonate of potash, and clear crystals of pure sulphate of potash were dissolved in the fluid while it was warm. When cold, the white heavy precipitate which at first appeared, was mixed with a more crystalline salt. Twelve hours after, no increase in the quantity of the latter salt was noticed. These precipitates were separated from the fluid, and washed in proof spirit. Hot water dissolved one part, leaving a heavy insoluble salt, which, after having been ignited, weighed 0·150 grain, and had the characters of sulphate of lead.*

D. The aqueous solution of the lighter salt, would afford no precipitate with ammonia. It was mixed with the proof spirit solution, and the whole boiled to disengage alcohol. Ammonia in excess, gave a yellow brown precipitate, as before, and when separated by a filter, washed, dried, ignited, and cooled, 0·320 gr. of a nearly black matter remained. A few drops of nitric acid dissolved this matter; crystals of carbonate of soda were added, and the whole ignited. On dissolving the salts, which were green colored, in water, a yellow solution resulted. The residue was dissolved in nitric, with a little hydrochloric acid, and the solution was decomposed by bicarbonate of ammonia in excess. After the precipitate had been ignited, it weighed 0·099. The carbonate of soda and ammoniacal solutions, contained oxides of uranium and manganese. Neither phosphoric acid, earths, or other metal-

* I here anticipate a doubt, which will arise in the mind of the reader, who has seen it stated that the original solution was saturated with hydrosulphuric acid. Contrary to the general belief, this acid does not decompose a solution of sulphate of lead in hydrochloric acid. The fact is one of importance, as some well waters, in contact with lead, cause this salt to form, and do not then give a precipitate with hydrosulphuric acid.

lic oxides, could be detected. The weight of mixed oxides, by difference, ·320 – ·099 = ·221.

E. On evaporating the fluid, which had given the precipitate of D, with a little oxalate of ammonia, a white precipitate was obtained. Heated with sulphuric acid to bright redness, 0·200 of pure sulphate of lime was left. Binoxalate of ammonia was added to the ammoniacal fluid of C, and by evaporation the white oxalate became granular. Separated by a filter, well washed, and converted into a sulphate, at a red heat, its weight, when cold, was 2·417. These sulphates were dissolved in 2000 grains of boiling water, without any residue. In the solution, ammonia afforded no precipitate; an excess of carbonate of ammonia would remove the whole of the base, as a granular precipitate, insoluble in oxalic acid. The solution, by evaporation, would afford crystals of sulphate of lime. The united weight of 2·417 and 0·200 = 2·617, or the equivalent of 1·087 lime.

F. The insoluble heavy powders of B and C, weighed ·350; treated with hydrochloric acid and water, were boiled; there remained undissolved a white powder, which was nearly pure columbic acid, weighing ·060. Ammonia was added to the solution, and an excess of sulphydrate of ammonia was digested on a black precipitate, which appeared. The fluid filtered off, was evaporated, and the residue calcined. There remained a nearly white peroxide of tin, weighing ·070. The black sulphuret was dissolved in cold diluted nitric acid, and afforded a colorless solution, which could be rendered neutral by ammonia. In it, chromate of potash would give a yellow precipitate; sulphuric acid, a white heavy powder; metallic zinc separated brilliant gray scales of lead. The weight of the sulphate of lead, by difference, was ·220, or the equivalent of ·160 of oxide of lead.

Ten grains of the microlite have thus afforded, of

Columbic acid, - - -	A and F,	7·960
Lime, - - - - -	E, -	1·087
Oxides of uranium and manganese,	D, -	0·221
Oxide of iron, - - -	D, -	0·099
Oxide of lead, - - -	F, -	0·160
Peroxide of tin, - - -	F, -	0·070
Loss, - - - - - - -	-	0·403

In this analysis, the columbic acid and lime have been carefully separated and weighed. The absence of yttria is proved, not only by trials in C and E, but by repeating the experiments described

by Prof. Shepard, on a separate portion of the mineral. Indeed, his own results do not favor the conclusion he adopted.

The columbic acid and lime represent, in their weights, nearly their combining proportions. I do not, however, regard this coincidence as proof, that *all* the columbic acid is really united to all the lime, in the mineral. The recent discovery, by M. Rose, of a columbate of uranium, may be regarded with interest, in this connection.

Pyrochlore.

The specimens used in the following analysis, were from the Fredericksvarn locality. The crystals were generally without modifications; but two of them had planes replacing the edges of the octahedron, and exhibited cleavage lines. Their colors varied from wax yellow to dark brown. Sp. gr. 4·203 to 4·221.

Analysis.—A. 20 grains lost by heating 0·160, or 0·800 per 100.

B. The fine powder was dissolved in melted bisulphate of potash, and after separating all other substances, there remained 10·590 of pure columbic acid, or 52·950 per 100.

C. After the fluids containing sulphate of potash, and the acids used in washing the columbic acid of B, were neutralized by ammonia, an excess of this alkali was added, and the precipitate which it produced was washed on a filter. The still moist and yellowish brown mass was digested in the sulphydrate of ammonia, which had been used on the columbic acid, for twelve hours. By evaporation, this solution afforded a yellow powder, which, by calcination, became a white oxide of tin, weighing 0·030.

D. The mass on the filter, C, was redissolved in sulphurous acid, containing sulphuric acid, and boiling water was used to wash a few black flocks which remained. On heating the black powder before the blowpipe flame, sulphur exhaled, and the addition of soda caused a globule of lead to separate; converted into oxide, it weighed 0·010. The soda globule left 0·030 of columbic acid. Ammonia was used to again separate the oxides which had been dissolved off the filter from lime, and the solution was removed with the usual precautions, leaving the light yellow oxides on the filter.

E. The filter containing the oxides in D was digested in a solution of oxalic acid; warm water dissolved all the matter it contained. Tartrate of ammonia and pure ammonia were added, till a precipitate which first appeared was redissolved, and the fluid

was alkaline. Sulphydrate of ammonia was added, and the vessel closed from the atmosphere. After twenty-four hours, a black precipitate had separated from the fluid. This was collected and calcined; 0·670 of a red brown powder remained. By nitric acid and fusion with carbonate of soda, a green mass resulted. Boiling water gave a greenish yellow solution, containing oxides of uranium and manganese. There was left, after the action of carbonate of soda, a red brown oxide of iron, which weighed 0·470. 0·670 − ·470 = ·200, is the weight of the mixed oxides of uranium and manganese.

F. The fluid from E was evaporated to a dry salt, which was heated in a platina vessel, allowing a current of air. When the carbonaceous matter had been removed, a light yellow oxide remained. When cold, the oxide was white, and possessed the known characters of titanic acid. It weighed 4·040.

G. In the fluid from C, binoxalate of ammonia gave a precipitate, which, converted into sulphate, weighed 7·547. When the fluid from D was treated in the same way, 1·824 of sulphate were obtained. These were dissolved in water, and proved to be pure sulphate of lime, denoting 3·890 of lime. Twenty grains of pyrochlore have thus afforded of

			Per 100.
Columbic acid, - - -	B and D,	10·620 × 5 =	53·100
Lime, - - - -	G,	3·890 =	19·450
Titanic acid, - - -	F,	4·040 =	20·200
Oxide of iron, - - -	E,	0·470 =	2·350
Oxides of uranium and manganese,	E,	0·200 =	1·000
Oxide of tin, - - -	C, 0·030	·040 =	0·200
Oxide of lead, - - -	D, 0·010		
Volatile matter lost at redness, - -		0·160 =	0·800
Loss, - - - - - -		0·580 =	2·900
		20·000	

In the above analysis, I have very briefly described the processes adopted for separating the constituents. I carefully examined the substances enumerated, and have been unable to discover others, which would not have been lost by the method chosen.

The following experiments have reference to the alkaline and volatile constituents. Three grains of pyrochlore were digested in hydrochloric acid, contained in a platina capsule. Over the fluid, a highly polished surface of glass was kept cool by water. The powder dissolved entirely, without causing any loss of

polish on the glass. The solution was heated to 212° F., and the excess of acid was allowed to escape. The fluid became turbid, and when dry, a transparent coating lined the vessel. Warm water dissolved the whole of the gum-like coating on the capsule, forming a nearly colorless, transparent solution. Ammonia caused a bulky white precipitate to form, and when separated by a filter, it closely resembled the hydrate of alumina, mixed with magnesia. The entire mass was soluble in very dilute hydrochloric, nitric, acetic, or tartaric acids. When its diluted solution in muriatic acid was treated with a minute quantity of a solution of sulphate of potash, columbic acid in its insoluble state was instantly disengaged, and rapidly subsided. The precipitate, after it had been washed and heated, weighed 1·770, corresponding to 59 per 100 of columbic acid. It was not pure, having carried down titanic acid, lime, &c. The fluid containing an excess of ammonia, from which the first precipitate had fallen, gave a precipitate with oxalate of ammonia. When calcined with sulphuric acid, sulphate of lime, weighing ·390, remained. By evaporating the fluid to a dry mass, and heating the residue, ·308 of chloride of sodium were obtained. On adding an excess of ammonia to the fluid, which had afforded the columbic acid by sulphate of potash, a precipitate was produced. The fluid and precipitate were saturated with hydrosulphuric acid gas. When the precipitate had been separated, the ammoniacal fluid was mixed with oxalic acid; the precipitate calcined with sulphuric acid, was sulphate of lime, weighing ·820. A trace of tin oxide was left, when this salt was dissolved in water. ·820 + ·390 = 1·210, or ·502 of lime. Oxalic acid dissolved the green precipitate containing sulphur, leaving traces of sulphuret of lead. By tartaric acid and ammonia, the titanic acid was retained, while sulphydrate of ammonia precipitated sulphurets of iron, uranium, and manganese. The titanic acid, left after burning off carbon, weighed ·550, and the oxides from the sulphydrate of ammonia precipitates ·020. Three grains, thus treated, gave—

Columbic acid, -	1·770	or, per 100 parts,		59·00
Lime, - - -	0·502	"	"	16·73
Titanic acid, - -	0·550	"	"	18·33
Soda, - - -	0·169	"	"	5·63
Oxides iron, uranium, &c.,	0·020	"	"	0·70
Volatile matter, -	0·002	"	"	0·80
	3·013			101·19

It was after this analysis had been finished some months, that a friend showed me the corrected results, published by M. Wöhler, as obtained in analyses of the pyrochlore from Maisk and Brevig. His results had shown the pyrochlore from these localities to be a columbate of lime, associated by crystallization with another mineral; the lime base being in part replaced by thorina and oxide of cerium.

I consider the chemical evidence as fully confirming the conclusions which Mr. Teschemacher had arrived at before it was obtained. The numbers which I have given as the weights of the constituents of the Fredericksvarn variety, lead to a chemical formula; but for reasons which will appear hereafter, I do not feel confident that the combining weight of columbic acid has been accurately determined.

Roxbury Laboratory, Dec. 4th, 1843.

ART. XX.—*On the* A *state of Columbic Acid;* by AUGUSTUS A. HAYES.

IN giving an account of an analysis of microlite, I alluded (*ante*, p. 159) to an error I committed, in mistaking columbic, for titanic acid. Pursuing the inquiries, I found the cause of the mistake to be some hitherto unknown characters of the columbic acid. The subject had been studied and results communicated to scientific friends, before the following abstract, from a paper by M. Wöhler was shown me. I give the abstract, as found in Berzelius's Report for 1841.—"Pure columbic acid, when heated nearly to the temperature of redness, becomes yellow; its white color being restored on cooling. When it is heated in a current of hydrogen, it becomes of a brownish black color, losing slightly in weight, and seems to pass to the state of a columbate of oxide of columbium, like the corresponding compound, tungsten. Columbate of ammonia gives the same compound, when heated to redness in close vessels. In decomposing by bisulphate of potash, at a red heat, a columbic mineral, there is obtained a columbic acid, containing sulphuric acid; which is not dissolved by digesting the mass in water, nor by the action of concentrated hydrochloric acid, used in washing it; but if left to digest in hydrochloric acid, and we afterwards add water, it dissolves. Boiling precipitates anew the columbic acid from the solution. Sulphuric acid, or a

sulphate, precipitates it almost entirely, in the form of a white heavy powder, from which the sulphuric acid is not driven off by simple calcination; but the columbic acid is completely freed from sulphuric acid, by heating the combination in an atmosphere of carbonate of ammonia. M. Wöhler considers the precipitation of columbic acid, by sulphuric acid, as a property characteristic of columbic acid. Columbic acid combined with sulphuric acid, and still moist, dissolves in caustic potash or soda, and is precipitated from such solutions by acids. Sal ammoniac precipitates a large part, but the precipitate is a columbate of ammonia. The moist sulphate of columbic acid, mixed with concentrated hydrochloric acid, in contact with zinc, produces a beautiful blue solution, which afterwards becomes brown, remaining clear. Ammonia, added in sufficient quantity to retain the oxide of zinc in solution, precipitates a hydrate, of a brown oxide of columbium, which becomes white, under the influence of air. Hydrochloric acid, with the aid of zinc, does not dissolve columbic acid, which has been dried; but the latter becomes blue. It remains colorless, if it has been calcined. This does not prove that it contains tungsten, for the acid which becomes blue does not exhibit this color, when heated by the blowpipe and reducing flame, with phosphoric salt. In calcining a mixture of columbic acid and sugar, in a covered crucible, reducing the product to a fine powder and heating it to redness in a current of dry chlorine; there is obtained a chloride of columbium, which possesses entirely different properties from the chloride we obtain in causing a current of chlorine to pass over columbium. M. Wöhler considers the product of this operation, as representing the combination of columbic acid and chloride of columbium, corresponding to the analogies of chrome, tungsten and molybdena. There is obtained a white sublimate, which forms vapors in the air, and which may be sublimed again, without decomposition and without becoming fused. The gas is colorless and condenses in the form of a silky mass, radiating and converging to a point. This combination is sometimes yellow; it partially melts and gives a yellow gas, as if it were mixed with pure chlorine. It dissolves in water, depositing columbic acid, in the form of jelly; which contains chloride of columbium, and which gives hydrochloric acid by calcination. The sublimate produces a clear solution with hydrochloric acid; it may be heated to boiling, without form-

ing a precipitate, but when by evaporation it arrives at a certain concentration, it deposits a white precipitate, which dissolves anew by the addition of a large quantity of water. It would appear that this sublimate contains columbic acid, in a different modification from that of the ordinary chlorides of columbium. This modification corresponds to the two different modifications of oxide of tin. Sulphuric acid precipitates columbic acid from the solution, even when it is found under this modification." These observations of M. Wöhler, I deem of much importance, to those engaged in analytical inquiries. The most trustworthy of the indications of the existence of titanic acid, in a solution, is the production of a blue color and precipitate by zinc. The development of a yellow color by heat, has been considered a distinctive property of titanic acid. The compounds of columbic acid have been considered insoluble in hydrochloric acid.

If we treat pyrochlore with pure hydrochloric acid, it readily dissolves, although from 50 to 80 parts per cent. of its weight are columbic acid. By evaporation, the solution becomes turbid, afterwards milky, and finally deposits a white opake salt, precisely as follows from the same treatment of a solution of a titanate. If the evaporation has been carried on at a moderate temperature, the salt is crystalline in appearance and remains soluble. Boiling the solution, causes the precipitate to become nearly insoluble in water, but the addition of hydrochloric acid effects a solution. When the salt has been dried, it loses its opake appearance, and becomes a transparent glass-like mass. Water acidulated with hydrochloric acid, readily dissolves the salt. Instead of pyrochlore, we may use pure columbic acid, which has not been heated, and a solution of titanic acid, or oxide of uranium, in hydrochloric acid. The hydrate of columbic acid dissolves freely, if it be mixed with either oxide of uranium, or titanic acid. In such a solution, it has assumed what may be called its A state. Ordinary columbic acid dissolves in acids and oxalates, to a certain extent, but such solutions have not the characters that those of the acid in its A state exhibit. *From an electro-negative or acid state, and without any apparent change of composition, it takes a positive or basic state.* It may be precipitated by carbonates of soda and potash; by pure and carbonate of ammonia, as a white hydrate, closely resembling alumina. This hydrate dissolves in most of the acids freely. A solution in hydrochloric

acid, much diluted, had the following reactions: With sulphuric acid, a white precipitate, which redissolves in an excess of the precipitant. Nitrate of potash, no change of appearance. Sulphate of ammonia, a white precipitate, soluble in acids. Sulphate of soda, the same; the precipitate is less soluble. Nitrate of soda, no change apparent.

The most remarkable action follows the addition of sulphate of potash. A solution containing only a minute quantity of this salt, annihilates as it were the A state of the columbic acid, and changes it to its ordinary state. At the instant of acquiring its usual acid relation to the substances present, it precipitates and carries down with it some portion of them in an insoluble state. If a solution of columbic acid in its A state, be boiled in a flint glass vessel, and afterwards a drop of sulphuric acid or a sulphate is added, a precipitate denoting the presence of sulphate of potash falls. When the columbic acid has been prepared by heating a native compound, with 6 or 8 parts of bisulphate of potash, it always contains sulphuric acid. A quantity of bisulphate equal to 12 or 15 times the weight of the mineral being used, the acid is readily obtained pure.

ART. XXI.—*Hints on the Iceberg Theory of Drift;*—in a letter from Mr. PETER DOBSON to Prof. EDWARD HITCHCOCK.

Extract of a Letter from Prof. Hitchcock.

MESSRS. EDITORS,—You will recollect that in Mr. Murchison's Anniversary Address before the London Geological Society, for 1842, he gives credit to Mr. Peter Dobson of Vernon in Connecticut, as "the original author of the best glacial theory;"* and in proof quotes a paper by Mr. Dobson in the Journal of Science for 1826. In looking over my papers lately, I found a letter from Mr. Dobson on this subject, written six years ago, which I send you, in the hope that you will publish it; because it carries out his views more minutely than does the paper referred to by Mr. Murchison; and these views are with him evidently original. I am the more inclined to do this, as I fear, from not finding any

* See this Journal, Vol. XLIII, p. 200.

mark to that effect upon it, that I never answered the letter; and if so I would gladly do something to atone for a seeming want of courtesy. I must say, however, that my first ideas of the joint action of ice and water in producing the phenomena of drift, were derived from the views of Sir James Hall concerning diluvial phenomena in Scotland; for he introduces floating ice as one of the agents; but he gives no such distinct ideas of this agency as Mr. Dobson and other recent advocates of the iceberg theory do.

Vernon, Nov. 15, 1837.

Mr. Hitchcock,—

Sir—I have read several good articles in the Biblical Repository written by you on geological subjects, and I have now before me the one on "historical and geological deluges." I have read what I have had an opportunity of seeing on these subjects, and for a number of years I have been noticing some facts, which I thought might throw some light on this interesting science; and as there is one physical fact that is common in this region that does not appear to be noticed by you, I take the liberty to address you on the subject.

It is common to find bowlders of red sandstone in this neighborhood, on and near the surface, as well as deep in the diluvial masses of earth, that have been partially rounded by attrition, and afterwards worn on one side rather flat, by a motion that has kept the bowlder in one relative position, as a plane slides on a board in the act of planing. Some of the bowlders are worn, and scratched so plain, that there is no difficulty in pointing out which side was forward, in the act of wearing, for it sometimes happens that there are minerals of quartz and feldspar in them, and if they happen to be in the part that has been worn, these minerals being harder have protected some of the softer part of the stone, so as to form a ridge from the mineral, as a wooden pin would, driven into the plank of a stone drag, in that part that is exposed to be worn by sliding on the ground.

Some of these bowlders are so nearly round, that a powerful current, sufficient to move them, would not cause them to slide but to roll; yet they have been made to slide so as to receive distinct scratches, and the projecting minerals, I have no doubt, have done some scratching on the rocks in place. Many of these bowlders when dug out of the earth have a freshness of appear-

ance, as if they had been recently worn, and the last act of wearing seems to have been sliding. I cannot account for the appearances on these worn bowlders, without their being enveloped in ice, and moved in ice by currents of water.

In the 66th number (Vol. xxxii) of the American Journal, edited by Mr. Silliman, is an article by Mr. Redfield on currents on the coast of this continent, and at page 351 he says: "It is doubtless true that the great stream of ice is brought by the Labrador current within the dissolving influence of the Gulf Stream; and I may here remark that it is not improbable that the Grand Bank owes its origin to the deposits which have resulted from the process for a long course of ages." (See also the note on the same page.)

I crossed the Grand Bank in April, 1809, and then there was ice spread over from ten to twelve degrees of longitude, commencing on the east side with small fragments in close contact, and as it extended westward it kept increasing in size, so that half the extent on the west side was large icebergs, say from twenty to forty feet high above the water, and a few miles apart. How far the ice extended north and south I have no means of knowing, but I saw so much ice, that when I have seen it mentioned that the icebergs seen almost every spring by ships crossing the Grand Bank, originated by fragments of ice breaking off from the coast of Davis's Straits, I have always considered the cause not equal to the effect, for in April any year all north of Hudson's Straits must be locked up by solid ice.

The article "Ice" in the Edinburgh Encyclopedia says, that in the north of Europe, "ice sometimes attaches itself to anchors in such quantities, as to raise them to the surface by its buoyancy;" and again, that "ice forms at the bottom of great thickness before it rises, and then brings up with it, not only earth and gravel, but stones of large size;" and many more facts of a similar nature.

Now why may not ice attach itself to bowlders and other loose materials at the bottom of the ocean, off the Labrador coast, in such quantities as to buoy up stones and other loose matter; and be floated along in the polar current, increasing in bulk by freezing after they rise to the surface; and in this way account for so much ice being seen annually, so early as April and May, on the Grand Bank?

It appears to me, that there are causes now in action on the northeast coast of this continent, that are producing effects similar to what has been done by diluvial currents on the surface of New England.

If you have not had an opportunity of seeing worn bowlders, such as I have described, I should be glad to have the pleasure of showing you some. Respectfully yours, &c.

PETER DOBSON.

ART. XXII.—*Notice of Travels in the Alps of Savoy, and other parts of the Pennine Chain, with observations on the phenomena of Glaciers;* by JAMES D. FORBES, F. R. S., Sec. R. S. Ed., Cor. Mem. of the Institute of France, and Prof. of Nat. Phil. in the Univ. of Edinburgh.*

THE beautiful work of Prof. Agassiz on the Glaciers, with its fine illustrations, produced so vivid and deep an impression, that the no less splendid volume of Prof. Forbes, finds the public mind already awakened, informed and eager for additional information, but not disinclined to receive any new theoretical views that promise to be stable; it cannot fail therefore to excite much attention, both on account of what it affirms and what it denies. The great work of the distinguished Swiss naturalist on the study of the Glaciers, as well as his labors in other departments of science, with the discussions which they have excited, we and our correspondents have frequently noticed.† In turning therefore to a successor and a friendly rival in the ice-fields of the Alps, we find new facts and new theoretical views, in a department which appeared to have been almost exhausted by the labors of De Saussure, Hugi, Necker, Escher, Lardy, Zumstein, Venetz, Charpentier, Studer, Rendu, and above all by those of Agassiz.

The travels of Prof. Forbes, are contained in a volume of 424 pages royal octavo, closely printed on beautiful paper. They are illustrated by nine excellent lithographic views of glaciers and ice-girt mountains and by two topographical maps, one large and folded; also by nine topographical sketches inserted in the body of the pages.

The text is divided into twenty one chapters and followed by an appendix. This work contains ample and exact details in topography,

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* Received through the kindness of the publishers, Adam & Charles Black, Edinburgh; and Longman, Brown, Green & Longman, London.

† See this Journal, Vol. XLI, p. 191—194; Vol. XLII, p. 346; Vol. XLIII, p. 390; Vol. XLIV, p. 146; Vol. XLV, p. 324, &c.

many new and valuable engineering observations taken with accurate instruments, and often made in painful or dangerous circumstances, among the eternal snows and treacherous ice-cliffs and glaciers of the Alps. It abounds with daring and hazardous adventures, contains notices of occasional catastrophes that have befallen less fortunate explorers; presents interesting discoveries, with new deductions, and is clothed in a style and diction entirely in keeping with the beauty and grandeur of the subject. If a literary reader would sometimes tire amidst the almost endless details, on Alpine snows, crevasses and glaciers, he would be relieved, at short intervals, by unrivalled beauty of description and sublime sketches of those scenes which are forever arrayed in a wild and terrible grandeur. We have perused the work with intense pleasure and large instruction, and with a conviction, if possible increased at every step, of the great energy of the action of glaciers in furrowing and scratching and polishing those rocks upon which they repose, if repose it can be called where there is no rest, since the glaciers are always advancing in immense fields and rivers of ice upon the country below; and were it not, that the melting at the lower end of the ice-cliffs prescribes limits to their extension, it is not easy to see why they would not eventually usurp dominion over a large portion not only of the polar but of the temperate zones of the earth, which they are supposed by Agassiz to have formerly covered.

Prof. Forbes accords with all other writers on the subject that "the snow which falls on the summit of the Alps, becomes converted into ice by successive thaws and congelations," but the explorers who have published their views have not been agreed as to the immediate cause of the descent of these frozen masses down the vallies and towards the plains. Dilatation by the freezing of water, and gravitation, include the principal theories.

The author denies that the descent of the ice is due to dilatation, while this cause, as he believes, contributes to swell the volume of the ice upward or at right angles to the bed of rock on which it lies. Gravitation, as he avers, could never move downward a rigid inflexible field of ice upon a rocky and uneven bottom, and often confined between projecting buttresses, where the approximation of mountain cliffs narrows the space into a gorge or strait, in the manner in which rivers are pent up by opposing walls.

The declivity of the *Mer de Glace* averages only 9°, and in many parts hardly equals that of many hills over which loads are drawn by animals; in many cases it does not exceed 5°—less than the slope of the great Simplon, which is a road for artillery, and often it falls far short of that amount; this fact renders it highly improbable, not to say impossible, that a firm field of ice should slide down such a gentle declivity, espe-

cially against all the obstacles that have been named, and over the jagged and rough projections of rocky defiles. It is found that the freezing of the water that percolates through the fissures of the ice penetrates but a small distance in summer, and in the winter, when the dilatation by freezing is the greatest, the motion of the glacier downward is the least, whereas upon the dilatation theory it should then be the greatest. In the summer season the motion is the most rapid, and then there is no internal congelation, and very little upon the surface. At seven thousand nine hundred feet above the sea, on the Montanvert, in the month of September, 1842, although in severe weather, the ice was, as usual, charged with water, except on the surface, where it was dry, but a little way down water was easily obtained by breaking the ice in a pool frozen over under a stone. The progress of the glacier downward was always retarded by the increase of cold, and augmented by a thaw. The snows which cover the ice appear to preserve in it an equality of temperature, as they do in the ground; for Prof. Agassiz himself found the ice at all depths within a fraction of 32°.

The supposed sliding motion of a solid mass of ice by gravity is inconsistent with the rapid progress of the middle of the mass, (taken in the direction of its length,) for it has been distinctly proved by Prof. Forbes, that the sides next to the rocky walls move the most tardily, and in no part of the summer is the ice frozen fast to the mountain sides.

It has been supposed by Saussure and others, that the heat of the earth causes a fusion of the bottom of the glaciers, lubricating their path, and thus facilitating their motion; but this effect must be extremely small, and has been considered, upon the theory of Fourier, equal only to melting a quarter of an English inch of ice in the space of a year. It would, therefore, be entirely inadequate to smoothing off the nether asperities of the glacier, which must impede its motion. Prof. Forbes, after setting aside the previous theories, announces his own, as follows: "A GLACIER IS AN IMPERFECT FLUID, OR A VISCOUS BODY, WHICH IS URGED DOWN SLOPES OF A CERTAIN INCLINATION, BY THE MUTUAL PRESSURE OF ITS PARTS," (by gravity, of course.) This is illustrated by the motion of a moderately thick mortar, or of melted tar, or treacle, down an inclined plane, fashioned in the form of a trough, and these materials will be found to be governed by their own viscosity and the friction on the channel.

"*That glaciers are semi-fluid is not an absurdity.*" Even water is not quite mobile; it requires a slope of 6 inches to a mile, or $\frac{1}{1000}$ part, to make it run freely, while some other fluid might require a slope of $\frac{1}{1000}$, and many bodies may be heaped up at an angle of many degrees before their parts will begin to slide over each other.

"That a substance apparently solid may, under a great pressure, begin to yield; yet that yielding or sliding of the parts over one anoth-

er may be quite imperceptible upon the small scale, or under any but an enormous pressure." A column of the body itself is the source of the pressure—a column often of several hundred or thousand feet in height,—the origin and termination of many of the largest of the glaciers having not less than four thousand feet of elevation between their origin and end. Were the glaciers suddenly converted into water, the bottom would move with a force of forty-four millions of feet, or eight thousand three hundred and thirty-three miles in twenty-four hours; whereas the velocity of a glacier is only about two feet in that time, implying a pressure, however, quite sufficient to produce the effect of slow descent. "A glacier is not coherent ice, but is a granular compound of ice and water, possessing under certain circumstances, especially when much saturated with moisture, a rude flexibility, sensible even to the hand." Glaciers do collapse, and thus choke up and close their own *crevasses* (fissures) with their plastic substance. A glacier contracts when embayed by rocks, and presses through a narrower channel than that by which it entered, and having passed the gorge into a wide valley, it spreads itself out wider, as a viscous substance would do.* *The motion of a glacier resembles that of a viscous fluid;* the velocity varies with the slope; the surface, especially the middle of the surface, moves fastest.

The higher and central parts of such a mass will move nearly together, while the bottom and sides will be most influenced by the friction. The mean velocity of the entire stream is the mean between that of the top and bottom. The flow will vary with the temperature; hot water runs out of an orifice more rapidly than cold. All these circumstances are imitated by the glacier. The centre of a glacier moves faster than the sides; the top than the sides and bottom. Glaciers slide over their beds in consequence of the particles of ice sliding over each other; the motion of the superficial parts pulling along the inferior. A glacier descending into a valley, is like a body pulled asunder and stretched, and not like a body forced on by superior pressure alone. "The glacier, like a stream, has its pools and its rapids. Where it is embayed by rocks, it accumulates; its declivity diminishes, and its velocity at the same time. When it passes down a steep, or issues by a narrow outlet, its velocity increases."

"*The veined structure of the ice is a consequence of the viscous theory.*" A viscous stream presents wrinkles, or curvilinear arrangements of the floating matter, accompanied by a crumpling, or inequality of the surface. The dirt bands described very minutely by Prof. Forbes, are at-

* An opinion first brought prominently forward by M. Rendu, now Bishop of Annecy.

tributed to this cause. The dirt and small stones are detained in those wrinkles or curved lines, which are soft and oozy with water, and thus the accumulated lines of dirt remain and exhibit a banded succession of earthy materials. The author has elucidated and confirmed these views by actual experiments made upon the flow of viscous and tenacious matters, which he finds to correspond with the great Alpine exhibitions. Bishop Rendu, of Annecy, has insisted upon the plasticity of the ice; moulding itself to the endlessly varying forms and sections of its bed, and he maintained that the centre of the ice stream moved the fastest. Captain Hall says, "When successive layers of snow, often several hundred feet in thickness, come to be melted by the sun and by the innumerable torrents which are poured upon them from every side, to say nothing of the heavy rains of summer, they form a mass not liquid, indeed, but such as has a tendency to move down the highly inclined faces on which they lie, every part of which is not only well lubricated by running streams resulting from the melting snows on every side, but has been well polished by the friction of antecedent glaciers. Every summer, a very slow but certain advance is made by these huge, sluggish, and bulky, half snowy, half icy accumulations."

Prof. Forbes justly remarks that no one has a right to assume the plasticity of the materials of glaciers as the foundation of a theory, until the fact has been proved by decisive observations and experiments. "These observations have been made, and the result is, the viscous or plastic theory of glaciers, as depending essentially on the three following classes of facts"—first ascertained by himself in 1842, the proofs being contained in the work now under consideration. For those details of proofs we have not room, but they are believed to sustain the following conclusions:

1. "That the different portions of any transverse section of a glacier move with varying velocities, and fastest in the centre."

2. "That those circumstances which increase the *fluidity* of a glacier, namely, heat and wet, invariably accelerate its motion."

3. "That the structural surfaces, occasioned by fissures which have traversed the interior of the ice, are also the surfaces of maximum tension, in a semi-solid or plastic mass, lying in an inclined channel."

The glaciers undergo a surprising depression during the summer, and a correspondent elevation in the winter. In the summer, the streams flowing beneath the glacier contribute to waste it; the warmer earth melts the inferior surface, and the lower extremity of the glacier, where it touches the fields, moves faster than the upper, thus drawing it out, and thinning it mechanically. The difference of level between summer and winter is sometimes twenty to twenty-five feet, and the depression of summer is certainly made up in the winter and spring. This may

be "partly owing to the dilatation of ice during winter, by the congelation of the water in its fissures, producing at the same time the veined structures." The glacier is, indeed, very far from being frozen to the bottom during winter, for a great portion of the icy mass is still plastic; but the congelation extends to a considerable depth, and produces the usual effects of expansion. This cause alone appears, however, to be inadequate to the effect, and the author attributes the elevation of the surface mainly to the diminished fluidity of the glacier in cold weather, which retards the motion of all its parts, and especially of those that move most rapidly in summer. The ice is more pressed together, and less drawn asunder; the crevasses are consolidated; "while the increased friction and viscosity cause the whole to swell, and especially the inferior parts, which are the most wasted."

"Such a hydrostatic pressure, likewise, tending to press the lower layers of ice upwards to the surface, may not be without its influence upon the (so called) rejection of blocks and sand by the ice."

It is well known that masses of stone, when below, rise to the surface, and those on the surface remain there, and continue age after age to travel downwards towards the plains. Prof. Forbes, although regarding the views expressed above as only conjectural, has, however, no doubt that the convex surface of the glacier (which resembles that of mercury in a barometer tube) is due to the hydrostatic pressure acting upwards with most energy near the centre. "Exactly contrary is the case in a river, where the centre is always the lowest; but that is on account of the extreme fluidity, so that the matter runs off faster than it can be supplied." This view is believed not to be inconsistent with the former supposed great extension of glaciers, even from Mount Blanc to the Jura mountains, of Geneva, more than fifty miles, in which case they must have moved "with a superficial slope of one degree, or in some parts even of a half or a quarter of that amount, whilst in existing glaciers, the slope is seldom or never under three degrees. The declivity requisite to insure a given velocity, bears a simple proportion to the *dimensions* of a stream. A stream of twice the length, breadth, and depth of another, will flow on a declivity half as great; and one of ten times the dimensions, upon one-tenth of the slope."

The author finishes his view of the philosophy of the glaciers with the following beautiful reflections: "Poets and philosophers have delighted to compare the course of human life to that of a river; perhaps a still apter similitude might be found in that of a glacier. Heaven-descended in its origin, it yet takes its mould and conformation from the hidden womb of the mountains which brought it forth. At first, soft and ductile, it acquires a character and firmness of its own, as an inevitable destiny urges it on in its downward career. Jostled and con-

strained by the crosses and inequalities of its prescribed path, hedged in by impassable barriers which fix limits to its movements, it yields to its fate, and still travels forward, seamed with the scars of many a conflict with opposing obstacles. All this while, although wasting, it is renewed by an unseen power,—it evaporates, but is not consumed. On its surface it bears the spoils which, during the progress of existence, it has made its own;—often weighty burdens, devoid of beauty or value—at times, precious masses, sparkling with gems or with ore. Having at length attained its greatest width and extension, commanding admiration by its beauty and power, waste predominates over supply, the vital springs begin to fail; it stoops into an attitude of decrepitude; it drops the burdens, one by one, which it has borne so proudly aloft; its dissolution is inevitable. But, as it is resolved into its elements, it takes all at once a new and livelier and disembarrassed form;—from the wreck of its members, it arises 'another, yet the same.' A noble, full-bodied, arrowy stream, which leaps rejoicing over the obtacles which before had stayed its progress, and hastens through fertile valleys towards a freer existence and a final union in the ocean, with the beautiful and the infinite."

Prof. Forbes spent many summers in exploring the Alps, encouraged the more to continue and repeat his arduous and adventurous journeys, because it has now become so easy to arrive promptly at the scene of one's explorations.

"The modern facilities for travelling extend not only to England, France, Germany, and what in former days was called *the grand tour*, but gentlemen now walk across Siberia with as little discomposure as ladies ride on horseback to Florence. Even the Atlantic is but a highway for loungers on the American continent, and the overland route to India is chronicled like that from London to Bath. The desert has its posthouses, and Athens has its omnibusses."

He appears strongly impressed by the belief that even in the countries most visited and explored, much more remains unknown than has been described, and "it is not too much to say, that the natural history of a great part of the chain of the Alps, the most instructive and the grandest theatre of natural operations in Europe, is in this predicament." Although the work of Prof. Forbes is avowedly a book of travels, its principal aim "is to illustrate the physical geography of a particular district, in one of the most frequented regions of the Alps; and more especially to arrive at results of a definite kind respecting the natural history of the glaciers, those great masses of ice which so generally attract the casual, though only the casual, notice of travellers." It is now a good many years since our author projected these travels, having visited the Swiss Alps in early youth, and having carefully refreshed

and strengthened his recollections by successive visits during a part of ten summers, to almost every district of the Alps between Provence and Austria. He has crossed the principal chain of the Alps twenty-seven times, generally on foot, by twenty-three different passes, and he has intersected the lateral chains in many directions. Unlike De Saussure, who frequently in his annual journeys travelled with ten or twelve men, as attendants, and four to six mules of burden—or Prof. Hugi, of Soleure, who often had with him twelve to fifteen companions and guides, largely paid, the Scotch professor pursued his inquiries almost alone. He employed neither draughtsman, surveyor, or naturalist. Every thing that it was possible to do, he executed with his own hands, noted the result on the spot, and extended it as speedily as possible afterwards. His only assistant was Auguste Balmat, a very intelligent and worthy guide of Chamouni. The work of Prof. Forbes is sustained by very recent observations. He spent the latter part of June, 1842, at the Montanvert, (Chamouni,) the first half of July on the southern side of Mount Blanc, and in Piedmont. Returning by the Montanvert, by the Col du Geant, he continued his experiments on the *Mer de Glace*, until the ninth of August. He then, in company a part of the time with Prof. Struder, passed a month in visiting Monte Rosa and the adjacent country, and finished September on or near the glacier at Chamouni.

His last date, in a communication from his faithful guide, Balmat, is even as late as June 8th, 1843—six months from this date, (December 8th, 1843.) The information relates to the descent of the ice near the Montanvert, which during the preceding nine months had been at the rate of nearly fifteen inches for twenty-four hours.

Snow line and glaciers.—High mountains are in every zone covered with snow;—the atmosphere grows colder and colder the higher we ascend into it, and therefore in ascending a high hill or mountain we pass through a succession of climates. "While the plains are covered with the verdure of summer, eternal winter reigns upon the summits; and thus the stupendous ranges of the Himalaya or the Andes present, in one wonderful picture, all the climates of the earth, from the tropics to the poles."

At the equator, the snow is permanent at 16,000 feet, a little more than three miles above the level of the sea. In the Swiss Alps, the snow line is 8,700 feet high. In very high latitudes, the snow line comes down to the sea level;—in such countries snow is the natural covering of the earth, and the very soil is frozen to an increasing depth. In the warm season snow melts in every climate; and if the snow which falls in one season is just melted and no more, then the snow line is stationary—if all that falls is not melted, then this line advances—and if more is melted, then it recedes.

But what is a glacier? "A snow-clad mountain is not a glacier." "The common form of a glacier is a river of ice filling a valley, and pouring down its mass into other valleys still lower. It is not a frozen ocean, but a frozen torrent. Its origin or fountain is in the ramifications of the higher valleys and gorges, which descend among the mountains perpetually snow-clad. But what gives to a glacier its most peculiar and characteristic feature, is, that it does not belong exclusively or necessarily to the snowy region already mentioned. The snow disappears from its surface in summer as regularly as from that of the rocks that sustain its mass. It is the prolongation or outlet of the winter-world above; its gelid masses protruded into the midst of warm and pine-clad slopes and green sward, and sometimes reaching even to the borders of cultivation. The very huts of the peasantry are sometimes invaded by this moving ice, and many persons now living have seen the full ears of corn touching the glacier, or gathered ripe cherries from the tree, with one foot standing on the ice."

"Thus much, then, is plain—that the existence of the glacier in comparatively warm and sheltered situations, exposed to every influence which can insure and accelerate its liquefaction, can only be accounted for by supposing that the ice is pressed onwards by some secret spring,—that its daily waste is renewed by its daily descent,—and that the termination of the glacier, which presents a seeming barrier or crystal wall immovable, and having usually the same appearance and position, is, in fact, perpetually changing—a stationary form, of which the substance wastes—a thing permanent in the act of dissolution." The thawing of the ice from the heat of the ground,—the flow of springs beneath,—the infiltration of rain and snow water from the heat of the sun, and the fusion of the ice by the rain, conspire to produce turbid rivers below the ice, and to excavate enormous arches and caverns.

Most of the water appears to be derived from the sun and the rain; and hence the Rhine and other great rivers supplied by Alpine sources, have their greatest floods in July, and not in spring and autumn, as would be the fact if they were fed by rain alone. The swell and roar of the torrents are far greater at noon than at evening, and in the morning are still less remarkable.

"The lower end of a glacier is usually very steep and inaccessible; sometimes the glacier falls in an icy cascade a thousand feet—the inclination being greatest at the beginning and termination, and least in the middle. The glaciers are covered with blocks of stone that have fallen from the cliffs, torn off by the expansion of freezing water, and precipitated by gravity as the sun dissolves the icy bands that held them fast to their native cliffs. As the glacier moves downward, the blocks are borne along in continuous lines on both sides, thus forming the mo-

raines, as they are called. The geology and mineralogy of inaccessible precipices, are thus learned by inspecting the masses that have certainly fallen from them."

"A glacier is an endless scroll, a stream of time, upon whose stainless ground is engraved the succession of events, whose dates far transcend the memory of living man." "Assuming roughly the length of a glacier to be twenty miles, and its annual progression five hundred feet, the block which is *now* discharged from its surface in the terminal moraine, may have started from its rocky origin in the reign of Charles I! The glacier history of two hundred years is revealed in the interval, and a block larger than the largest of the Egyptian obelisks, which has just commenced its march, will see out the course of six generations of men ere its pilgrimage too be accomplished, and it is laid low in the common grave of its predecessors."

The mean or middle portion of the glacier, is a gently sloping torrent, from half a mile to three miles wide—more or less undulating on its surface, and more or less broken up by crevasses of a few inches to many feet in width, and sometimes extending across the glacier, and to a frightful depth.* They often impede, and sometimes arrest the traveller, even when they appear trifling at a distance; and they abound with hollows, into which innumerable rills are precipitated, and combine into large streams—thus establishing an extensive drainage, often attended by bold and beautiful cascades. As the glaciers rise in winter, they elevate the blocks of stone with them, and in consequence of their sliding or rolling off laterally, they are often lodged on high ledges, where they are left when the glacier sinks;—they frequently fall also over the sides of the glacier next to the rocky barrier, or they are tilted into the crevasses and hollows, and by the motion of the icy flood are ground and chafed, losing their angular form, and producing grooves and scratches parallel to the motion of the ice.

Two glacier streams sometimes unite and become confluent, and each bearing along its line of rocks, two lines may thus combine into one—producing medial or middle moraines composed of different ruins, while the exterior line of each continues distinct.

It is obvious that by the confluence of several glaciers, several middle moraines may be produced. "The moraines remain upon the surface, and are rarely dissipated or engulphed; on the contrary, the largest stones are set on a conspicuous preëminence—the heaviest moraine, far from indenting the surface of the ice, or sinking among its substance, rides upon an icy ridge as an excrescence, which gives to it

* Nine hundred feet on Mont Blanc, as recently observed by Dr. Grant, an intelligent American traveller.—Eds.

the character of a colossal backbone of the glacier, or sometimes appears like a noble causeway, fit indeed for giants, stretching for leagues over monotonous ice, with a breadth of some hundreds of feet, and raised from fifty to eighty feet above the general level. Almost every stone, however, rests on ice ;—the mound is not a mound of debris, as it might at first appear to be. Nor is this all. Some block of greater size than its neighbors, covering a considerable surface of the ice, becomes detached from them, and seems shot up upon an icy pedestal. This apparent tendency of the ice to rise wherever it is covered by a stone of any size, results from the fact, that its surface is depressed every where else by the melting action of the sun and rain,—the block like an umbrella protects it from both,—its elevation measures the level of the glacier at a former period, and as the depression of surface is very rapid—amounting to a foot per week during the warm months of summer—the ice, like the fields, puts forth its mushrooms, which expand under the influence of the warm showers, until the cap becoming too heavy for the stalk, or the centre of gravity of the block ceasing to be supported, the slab begins to slide, and falling on the surface of the glacier, it defends a new space of ice, and forthwith begins to mount afresh. These appearances are called Glacier Tables, and their origin was perfectly explained by Saussure."

Sand washed into the hollows, eventually forms a protection from farther melting, and the hollows, by the melting of the surrounding ice, form cones of great regularity, twenty or thirty feet high, and eighty or one hundred in circumference.

The snow as regularly disappears and melts from the surface of the glacier, as it does from the surface of the ground in its neighborhood ; but it disappears more tardily as we ascend, and at length we reach a point where it never disappears at all, and this is the snow line upon the glacier. The term *névé*, used by modern glacialists, means that part of the glacier which is covered with perpetual snow ; it is where the surface of the glacier begins to be annually renewed by the unmelted accumulation of each winter, and the stratification is entirely obliterated as the *névé* passes into complete ice.

The icebergs of the polar seas are chiefly *névé*, or consolidated snow. It is far more easily fractured than ice, and also more easily thawed and water-worn, " hence the caverns in the *névé* are extensive and fantastical, often extending to a great distance under a deceptive covering of even snow, which may lure the unwary traveller to destruction. Sometimes through a narrow slit or hole opening to the surface of the *névé*, he may see spacious caverns of wide dimensions, over which he has been ignorantly treading, filled with piles of detached ice-blocks, tossed in chaotic heaps, whilst watery stalactites—

icicles of ten or twelve feet in length—hang from the roof, and give to these singular vaults all the grotesque varieties of outline which are so much admired in calcareous caverns, but which here show to far greater advantage in consequence of their exquisite transparency and lustre, and from being illuminated, instead of by a few candles, by the magical light of a tender green, which issues from the very walls of the crystal chambers."

"Considering then the glaciers as the outlet of the vast reservoirs of snow of the higher Alps—as icy streams moving downwards, and continually supplying their own waste in the lower valleys, into which they intrude themselves like unwelcome guests, in the midst of vegetation and to the very threshold of habitations—it is a question of the highest interest to explain the cause of this movement of the ice.

"The glacier moves on, like the river, with a steady flow, although no eye can see its motion; but from day to day, and from year to year, the secret silent course produces the certain slow effect; the avalanche feeds it and swells its flowing tide; the mightiest masses which lightning, or the elements roll from the mountain side upon its surface, are borne along without pause; when the glacier advancing beyond its usual limit, presses forward into the lower valleys, it turns up the soil, and wrinkles far in advance the green sward of the meadows, with its tremendous ploughshare; it brings amongst the fields the blasts of winter, and overthrows trees and houses in its ruthless progress; no combination of power and skill can stay its march, and who can define the limits of its aggression! Its proud waves are however stayed, and by causes as mysterious as those of its enlargement; it retreats year by year within its former limits; but where the garden and the meadow were, it has left a desolate spread of ruin, like the fall of a mountain, which never again may be tilled, and over which for at least half a century, not even a goat shall pick the scanty herbage."

The transporting power of glaciers is wonderful—superior to that of any other power—unless it be that of icebergs, those floating glaciers, which however exhibit only another mode of the same action.

Vast masses of primitive rocks, that have apparently undergone little wear and tear in travelling, are found upon secondary or alluvial surfaces, at a great distance from their origin. These masses have obviously been deposited during the more recent periods of the earth's physical history, and no considerable changes of surface have occurred since. They are superficial, naked, often lying upon bare rock, or upon sand or gravel, and often they are in such delicate positions as to equilibrium, that earthquake or deluge would have easily displaced them. Perhaps Prof. Playfair, of Edinburgh, first pointed out the importance of glaciers as a moving power; he understood their motion,

and was much impressed by the magnitude and variety of the ruins which they transport, even where there is little declivity, and over ground quite uneven. In a journey in 1816, he observed the masses on the Jura, and he distinctly attributed them to glaciers which once crossed the lake of Geneva and the plain of Switzerland, and he denies that a current of water, however powerful, could have carried huge *blocs* up steep declivities. That there has been great variation in the extent of the glaciers is proved by the fact, that between the eleventh and the fifteenth centuries, passes in the mountains which are now rarely traversed at all, were often threaded by the inhabitants on foot and on horseback.

It is well known that Venetz, De Charpentier, and especially Agassiz, have given great extent to the glacial theory, and Agassiz "has attempted to extend it with some variations to every part of the temperate zone, and to explain the distribution of the Scandinavian blocks and those of Great Britain by a similar action."

Whatever may be thought of this extension, Prof. Forbes considers the admission of glaciers one hundred miles long or more, as a less extravagant hypothesis than might be imagined. The absence of such a degree of cold in the existing climate, and the want of a sufficient declivity, are obvious objections to this view. But "the quantity is often so great as almost entirely to conceal the mass of the ice under the prodigious load, which, during a long descent, is accumulated upon them." In some cases they fill up entire valleys. Masses may now be seen on the glaciers, nearly or quite as large as those in the valleys. The author estimated the magnitude of a block which he saw in the valleys, as being nearly one hundred feet long and forty or fifty feet high, and a fragment of slate in the valley of Saas pushed along by the glacier of Swartzburgh, is estimated to contain two hundred and forty four thousand cubic feet, which would require an average diameter of nearly sixty two feet. Glaciers chafe and polish the rocks over which they are pushed or dragged; they wear down the solid granite, or slate, or limestone. "They rub and wear and polish the rocks with which they are in contact. Struggling to dilate, they follow all the sinuosities and mould themselves into all the hollows and excavations they can reach, polishing even overhanging surfaces."

Glaciers carry along with them masses of pulverized gravel and slime, which, pressed by the enormous superincumbent weight of ice, do effectually grind and smooth the surface of the rocky bed; the turbid water of the glaciers, charged with the fine material that has been ground between the rock and the ice, exhibits the same appearance from age to age.

The harder fragments are set in the ice as the emery is set in the wheel of the lapidary, and "the gravel sand and impalpable mud are the emery of the glacier." The glaciers are always wearing, scratching, marking, and polishing the sides of the rocks against which they are pressed in their downward progress, and these lateral grooves are often visible at great elevations, even far above any existing glaciers. This is remarkably exhibited in the defiles and mountain cliffs between the primary Alps and the secondary Jura mountains.

These ranges are parallel with the great valley of Switzerland which lies between them and is dotted with lakes; the direction of the valley is N. E. and S. W.: it is about thirty English miles wide, but the distance from the highest part of the Alps to the highest part of the Jura, is not less than eighty miles. "Near to the great gap in the main chain formed by the valley of the Rhone we have the lake of Neufchatel, with mountains of secondary limestone, in some parts of the age of the English oolite, and rising to about three thousand feet above the valley." Upon the slope of this range, and at a considerable elevation above it and facing the valley of the Rhone, there are extensive deposits of angular *blocs* of granite, of the kind found on the eastern side of Mont Blanc, the nearest spot where these rocks occur *in situ*, and no rock in the least similar is found any where in the Jura, or nearer than that part of the Alps already named, "and which may be sixty to seventy miles distant as the crow flies." "A great belt of these *blocs* occupies a line, extending for miles, at an average height of eight hundred feet above the level of the lake of Neufchatel, and above and below that line they diminish in numbers, although not entirely wanting." Multitudes of them have been broken up and removed for architectural purposes, or merely to clear the land, and many are concealed among the trees of the mountain forests, "but wherever seen, they fill the mind with astonishment, when it is recollected that as a matter of certainty, these vast rocks, larger than no mean cottages, have been removed from the distant peaks of the Alps, visible in dim perspective amidst the eternal snows, at the very instant when we stand on their debris. The celebrated bowlder called Pierre a Bot, or toadstone, in this vicinity, about two miles west of Neufchatel, is fifty feet long, twenty wide, and forty high, and contains forty thousand French cubic feet. It forms a stupendous monument of power. It is impossible to look at it without emotion, after surveying the distance which separates it from its birth-place." There are besides in the neighborhood, hundreds and thousands of truncated *blocs*, some small and rounded, but a vast number exceeding a cubic yard in contents and perfectly angular, or at least with only their corners and edges slightly worn, but without any appearance whatever of considerable attrition, or any violence having

been used in their transport. Indeed, such violence would be quite inconsistent with their appearance and present position." The *blocs* are distributed in an orderly manner, those from the same origin being generally grouped together.

The author rejects the idea that these masses were driven along by rushing water, that they slid down an inclined plane, or even that they were transported upon floating rafts of ice, and favors or perhaps espouses the theory of their transportation by glaciers that once occupied the whole intervening space between the high Alps and the Jura, filling of course the valley of Switzerland, and crossing its numerous lakes; the recession being gradual through a long series of years, and depositing the moraines or lines of rocks as they are now found on the Jura, and as they are at this moment in the course of being deposited towards the heads of the valleys. Between the Alps and the lake of Geneva, into which the Rhone empties, this river passes through a narrow and deep gorge in the mountains at St. Maurice—a grand scene, which is familiar to all Swiss travellers.

"If the glacier which then filled all the upper and tributary valleys, whose waters now form the current of the Rhone, passed through this place, it must have been violently accumulated in this ravine, and pressed with excessive force upon the bottom and sides of the valley. The marks of glacier wear and polish are here extremely visible, especially on the rocks which occupy the bottom between St. Maurice and Bex; and they extend to a very great height on the eastern side of the valley, exactly opposite to the village of Bex, where M. de Charpentier pointed out to me the most exquisitely polished surfaces of rocks, quite as smooth as a school-boy's slate, and displaying an artificial section of all the interior veins. After passing the defile of St. Maurice, the glacier spreads itself over the enlarged basin immediately beyond, partly formed by the tributary Val d'Illiers. The whole face of that valley fronts the tide of ice which then flowed through the rocky defile, (on the theory we are discussing,) and which bore upon it with its lateral moraine. The result is not less surprising than what we have described on the Jura."

The rock here too is limestone, and not more than a quarter of the distance from native granite, but the magnitude of the moraine is proportionally greater. The "blocs of Monthey," as they are called from the village immediately below them, must be seen to be appreciated. "I wandered amongst them (says the author) a whole forenoon, and though I had previously heard much of their magnitude, I had formed no idea of what I then saw. We have here again a belt or band of *blocs*, poised as it were on a mountain side, it may be five hundred feet above the alluvial flat through which the Rhone winds below. This

belt has no great vertical height, but extends for miles—yes, for miles along the mountain side, composed of *blocs* of granite thirty to forty, fifty and sixty feet in the side—not a few, but by hundreds, fantastically balanced on the angles of one another, their gray weather-beaten tops standing out in prominent relief from the verdant slopes of the secondary formation on which they rest."

"For three or four miles there is a path preserving very nearly the same level, leading amidst the gnarled stems of ancient chestnut trees, which struggle round and among the piles of *blocs*, which leave them barely time to grow. The trees, opening here and there, display the rich cultivated valley of the Rhone beneath, whilst the snow-clad Alps, whose fragments are beneath our feet, close the farther distance. The *blocs* are piled one on another, the greater on the smaller, leaving deep recesses between, in which the flocks or their shepherds seek shelter from the snow-storm, and seem not hurled by a natural catastrophe, but as if balanced in sport by giant hands. For how came they thus to alight on the steep and there remain? What force transported them, and when transported, thus lodged them high and dry, five hundred feet at least above the level of the plain? We reply a glacier *might* do this. What other inanimate agent could do it we know not."

Our author clambered to the top of the precipices, fifteen hundred feet above the valley of the Rhone, which form the mural angle between the Sallenche River and the Rhone. Now, these vertical precipices on which repose erratic *blocs*, are "scored by horizontal stripes, or grooves, or fluting, evidently the result of superficial wear. But what could have worn it in this position? What could have been moved with a steady pressure, as a carpenter presses his cornice plane to the wood, or as a potter moulds with a stick his clay, pressed laterally too with a perpendicular face of fifteen hundred feet beneath? Nothing that I am acquainted with save a glacier, which, at this day, presses, and moulds, and scores the rocky flanks of its bed, extending to a depth often certainly of hundreds of feet beneath. A torrent however impetuous, a river however gigantic, a flood however terrific, could never do this." Among modern ruins of the moraines we may cite that of 1820* at the Humeau des Bois, where the erratic rocks "lie scattered almost at the doors of the houses, and have raised a formidable bulwark at less than a pistol shot distance, where cultivation and all verdure suddenly cease, and a wilderness of stones of all shapes and sizes commences, reaching as far as the present ice."

* The period of the greatest extension of this glacier.

We have already made more extensive citations than we intended from this very interesting work, and shall conclude with a few miscellaneous selections.

The crevasses of the *Mer de Glace* were observed to extend two thousand feet, or sometimes half across the glacier, and to be often fifteen or twenty feet wide, with walls perfectly vertical; they are evidently in some cases formed by the straining of the ice over obstacles; they begin with a sudden noise, and at first are mere cracks into which the blade of a knife would scarcely enter. They are often obliterated or closed up, especially in winter, and are in a good measure renewed every year, and chiefly in summer, when they frequently undergo a prodigious enlargement. On the Montanvert there is a moraine two hundred and forty feet above the present glacier, thus proving its former elevation. Professor Forbes found the remains of what was believed to be Saussure's ladder, which he left in the glacier in 1788; and comparing dates and distances, it appears to have travelled 16,500 feet in forty-four years, at the rate of 375 feet per annum for the motion of this part of the glacier; but observations made in other places gave an approximation to five hundred feet in a year. It seems not unreasonable to conclude that the rate of descent may vary in different glaciers. The apparent elevation of rocks by the sinking of the ice around them, has been mentioned. In connection with the medial moraine of the Talafre, there was a very remarkable stone of this description. It was twenty-three feet long by seventeen feet, and three and a half thick. On the 6th of June, 1842, it stood on an elegant pedestal of ice very delicately poised, and upon this stone the traveller erected his theodolite to make his observations. On the 13th of August, the supporting pedestal was thirteen feet high, and soon after the stone slipped from its position, and in September it was beginning to rise again upon a new icy column, or in other words, the glacier was wasting all around it, and the stone protected the portion on which it reposed, so that it relatively rose.

A rock that had been smoothly rounded by attrition, was called by Saussure *Roche montonnée.*

Near Pont Pelissier such rocks are accompanied by bowlders, "one of which of immense size and angular shape seems poised on the very summit of one of these beehive-like summits;—rocks so situated are called by De Charpentier *blocs perchées.*

"Near St. Gervais are numerous and extensive moraines, although the nearest modern glacier is some hours' walk distant. The rocks in place are slaty limestone, but *blocs* of granite abound, sometimes accumulated in ridge-like mounds along the face of the slopes exactly like moraines—in other cases insulated and of great size, thirty or forty feet in length; and they are well characterized protogine or granite of the

chain of Mont Blanc. The Pavillon de Bellevue on the Col de Bellevue, is nearly seven thousand feet above the sea, and yet erratic *blocs* are strewed all around upon it. These erratic *blocs* mix insensibly with the modern moraine of the glacier of Bionassy beneath, so that it is impossible to say where the erratic phenomenon ends and where the glacial phenomenon begins."

A very striking argument in favor of the glacial theory of erratics is thus presented on the spot, and these very *blocs* of protogine granite continue for many miles down the country without any intermission. The Lac de Combal is bounded by moraine; it pushes along several miles in length, nearly a mile in breadth, and several hundred feet deep. "The old moraines are still fortified with slits for musquetry, probably erected by the Piedmontese troops in 1794. It is strange to see this application of the artificial looking mounds which the glacier has raised, and which bear no slight resemblance to a series of gigantic outworks of an extensive fortification." The moraines are here formed in the shape of semilunar curves or crescents, of which there are four, with their convexity up the valley; and the outermost of these was occupied as a fortification. "The icy torrent as it spread out in the Allée Blanche, appeared to me to be three and a half miles long, and one and a half wide. After struggling for a long time among fissures and moraines, I at length mounted a heap of *blocs* higher than the rest, and surveyed at leisure the wonderful scene of desolation, which might compare with that of chaos, around me. The fissures were so numerous, large and irregular, as to leave only a series of unformed ridges, like the heaving of a sluggish mass, struggling with intestine commotion, and tossing about over its surface, as if in sport, the stupendous blocks of granite which half choke its crevasses, and to which the traveller is often glad to cling, when the glacier itself yields him no farther passage. It is there that he surveys with astonishment the strange law of the ice-world, that stones always falling seem never to be absorbed—that, like the fable of Sisyphus reversed, the lumbering mass, ever falling, never arrives at the bottom, but seems urged by an unseen force still to ride on the highest pinnacle of the rugged surface. But let the pedestrian beware how he trusts to these huge masses, or considers them as stable. Yonder huge rock, which seems 'fixed as stable Snowdon,' and which interrupts his path along a narrow ridge of ice, having a gulf on either hand, is so nicely poised, 'obsequious to the gentlest touch,' that the fall of a pebble, or the pressure of a passing foot, will shove it into one or the other abyss, and the chances are, may carry him along with it. Let him beware too, how he treads on that gravelly bank, which seems to offer a rough and sure footing, for underneath there is sure to be the most pellucid ice; and a light footstep there, which

must not disturb a rocking stone, is pregnant with danger. All is on the eve of motion. Let him sit awhile, as I did, on the moraine of Miage, and watch the silent energy of the ice and sun. No animal ever passes, but yet the silence of death is not there; the ice is cracking and straining onward—the gravel slides over the bed to which it was frozen during the night, but now lubricated by the effect of the sunshine. The fine sand detached loosens the gravel which it supported—the gravel the little fragments, and the little fragments the great; till, after some preliminary noises, the thunder of clashing rocks is heard, which settle into the bottom of some crevasse, and all is again still."

Among the many dangers encountered in travelling through these regions, not the least arises from the fall of stones. "A stone, even if seen beforehand, may fall in a direction from which the traveller, engaged amidst the perils of crevasses, or on the precarious footing of a narrow ledge of rock, cannot possibly withdraw in time to avoid it, and seldom do they come alone. Like an avalanche, they gain others during their descent. Urged with the velocity acquired in half rolling, half bounding down a precipitous slope of a thousand feet high, they strike fire by collision with their neighbors—are split perhaps into a thousand shivers, and detach by the blow a still greater mass; which once discharged, thunders with an explosive roar upon the glacier beneath, accompanied by clouds of dust or smoke produced in the collision. I have sometimes been exposed to these dry avalanches; they are among the most terrible of the ammunition with which the genius of these mountain solitudes repels the approach of curious man. Their course is marked on the rocks, and they are most studiously avoided by every prudent guide."

The story of the debacle of the Val de Bagnes in 1818, is adverted to, p. 262, and Prof. Forbes became acquainted with the very ingenious engineer, M. Venetz, who so ably endeavored to arrest the catastrophe of Martigny. The event has been often adverted to in geological travels. A mountain torrent formed by the snow floods, augmenting the river Drause, which was dammed up by the ice, formed a lake one mile and a half long, seven hundred feet wide and at one part two hundred feet deep. This dam M. Venetz sluiced by a canal six hundred feet long, with the labor of thirty four days, but the ice gave way and "a deluge of five hundred millions of cubic feet of water was let loose, in the space of half an hour, to sweep through a tortuous valley full of defiles, literally with the besom of destruction. A flood five times greater than that of the Rhine at Basle, filled the bed of a mountain torrent. In the short space of its course from Getroz to Chable, the fall is 2,800 feet; its acquired velocity was therefore enormous at the commencement of its course, thirty three feet in a second, and therefore its power

to overthrow buildings and to carry with it trees, haystacks, barns and gravel, cannot surprise us. Enormous masses of rock were moved, but there is no evidence that granite masses were brought down from the higher valleys by the torrent." A similar catastrophe happened in this valley twice in the 16th century, and to prevent its occurrence, men are employed during many weeks in summer, by turning upon the ice streamlets of water, which saw it in two; but a permanent tunnel through the mountain, appears to promise the only certain protection.

An electrical phenomenon occurred at an elevation of more than 9000 feet above the sea, which although not uncommon, may be worth mentioning, (p. 323.) The ground was covered with half melted snow and some hail was falling, when a curious sound was heard to proceed from the Alpine pole with which the traveller was walking. On holding his hand above his head, the fingers gave a whizzing sound, and it became apparent that they were so near a thunder cloud as to be highly electrified by it. All the angular stones around were perceived to be hissing like points near a powerful electrical machine. One of the guides was carrying an umbrella against the hail storm, and its gay brass point was likely to become the *paratonnécre* of the party; he was therefore requested to lower the point, and the word was hardly uttered before a clap of thunder unaccompanied by lightning justified the precaution. They found some *huts of miners* 10,800 feet above the sea, the highest temporary habitation in Europe.

In closing our extracts from this great work, so rich in valuable and interesting materials, we cannot deny ourselves the pleasure of giving an abridged account of a sketch by which Prof. Forbes illustrates the danger of wandering *alone* amid these icy regions. On the 17th of September, 1842, having with his guide ascended a lonely promontory whose "vast sheets of granite nearly vertical, occur up to a great height, with a sort of shelf above the glacier level, covered with detached masses of granite;" he sent Auguste in search of water. Becoming uneasy at the long absence of the man, Prof. Forbes proceeded in search of him and met him with two lads of Chamouni, leading between them an American traveller, whom with much difficulty they had rescued from a ledge of rocks on which he had passed the whole night. The adventurer had rambled alone on the morning of the preceding day over these solitary precipices, and toward afternoon having slipped over a rock where his fall was checked by some bushes, he found himself on a ledge of granite, shut in on every side. Here he had passed the whole night, and having in the morning by his cries succeeded in attracting the attention of some young men from Chamouni, who were passing far below, with much danger by a circuitous path they were able to gain a position above him. Their efforts would have been in vain

had not the guide of Prof. F. providentially encountered them while on his search for water. With great strength and courage Balmat succeeded in drawing the man up by the arm from "a spot where a chamois could not have escaped alive." Auguste told Prof. F. that while he bore the entire weight of the man on the slippery ledge of rock to which he himself clung, he felt his foot give way and for a moment thought himself lost. After having refreshed the exhausted traveller with food and wine, he was conducted back to Chamouni, while Prof. Forbes with his guide, went to view the place from which he was rescued. It was a ledge in most places about a foot wide and several feet long, with grass and juniper growing upon it. It thinned off upon the cliff entirely in one direction, and on the other where widest, terminated abruptly against an overhanging rock ten feet high, which no one unassisted could have ascended. "The direction of his fall was attested by the shreds of his blouse hanging to the bushes which he had grazed in his descent; but for which evidence it would have seemed impossible that any falling object could have so attained the shelf on which he was miraculously lodged. Immediately below the spot from which he fell, the shelf thinned off so completely that it was plain he must have fallen obliquely across the precipice so to reach it. "The ledge was twenty feet below the top of the smooth granitic precipice, to which a cat could not have clung, and below, the same polished surface went sheer down without a break for at least two hundred feet where it sinks into the glacier." "A more astonishing escape it is scarce possible to conceive. It is probable that had not the young men crossed the glacier at this fortunate moment, my guide and I would have passed the rock fifty yards above him, (it was in the direction in which we were going,) without either party having the remotest idea of the other's presence."

It is painful to conclude this story with the following note of Prof. Forbes, p. 83. "I regretted to learn afterwards, that he had not shown himself generously sensible of the great effort used in his preservation."

Art. XXIII.—*Bibliographical Notices.*

1. *Reliquiæ Baldwinianæ: selections from the correspondence of the late Wm. Baldwin, M. D., Surgeon in the U. S. Navy, with occasional notes, and a short biographical memoir;* compiled by Wm. Darlington, M. D. Philadelphia, 1843. pp. 346, 12mo.—In editing the scientific remains of the amiable Baldwin, Dr. Darlington has fulfilled, and well fulfilled, a duty peculiarly incumbent upon him; for he is certainly the appropriate literary executor of his lamented friend. Born in the same county, and nearly of the same age, the subject of this

volume and its editor, while fellow-students at the medical school of Philadelphia, were drawn together by kindred tastes, and early became cultivators of the science in which they have both distinguished themselves;—the one as the historian of the plants of his native district; while the other gathered his early laurels in the almost untrodden savannahs of Georgia and Florida, and soon after, when just entering upon a field of still richer promise, found an untimely grave on the banks of the Missouri. In his latest communications, Dr. Baldwin consigned his botanical papers to the charge of the late Mr. Zaccheus Collins and Dr. Darlington. They were accordingly placed in the hands of Mr. Collins, who purchased of the heirs at law the collection of dried plants, intending, it seems, to present it to the Academy of Natural Sciences of Philadelphia. It is much to be regretted that Dr. Baldwin was prevented by professional engagements and infirm health from completing his notes upon his rich collections in the Southern States, according to his original intention, before joining the western exploring expedition commanded by Major Long. For these manuscripts, as we know from personal examination, contain a very skillful revision of some difficult genera, especially in the Cyperaceæ, accurate diagnoses of new or ill-understood species, and original observations much in advance of the general state of botanical knowledge with us in those days; and their timely publication would not only have largely contributed to the advancement of his favorite science, but have formed the most enduring record of his labors and attainments, as well as the most appropriate monument to his own memory. Although bright hopes and high promise were thus frustrated by death, yet Dr. Baldwin's hard-earned scientific reputation might still have been in some good degree secured, had these manuscripts fallen into judicious editorial hands at an earlier period; when their scientific importance would have justified, or rather have required their publication, even in the imperfect state in which the author left them. But Dr. Darlington naturally felt a delicacy in interfering with the first-named executor, Mr. Collins, who also possessed the herbarium; but whose excessive caution, as it deterred him from publishing any of his own observations, (or even from giving, so far as is known, a decided opinion upon a botanical question during his whole life, except in a single instance,) would alone effectually have prevented him from taking such responsibility with the writings of another person. Indeed, the manuscripts were supposed to be lost, and they only came to Dr. Darlington's knowledge very recently, after he had arranged the principal contents of this volume for the press, and when they had ceased to possess other than historical interest. For the steady progress of the science during the last twenty years has nearly annihilated their strictly scientific value, the new plants having mostly been published already

by contemporary or succeeding botanists; one of whom, we are sorry to say, has not always paid the deference which courtesy and common justice require to the names under which the discoverer distributed them. Under these circumstances, and remembering that this lamented botanist seems to have deprecated the indiscriminate publication of his unfinished papers, we are convinced that the judicious editor could not do otherwise than disregard, as he has done, these once invaluable materials, and leave the reader to gather a general idea of Dr. Baldwin's indefatigable labors and rare promise, from the perusal of his familiar letters. About half the volume is accordingly occupied with the correspondence between Baldwin and Muhlenberg, which, commencing in the year 1811, and actively carried on until the death of that estimable botanist, in 1815, abounds with interesting matter, and contains many casual notices of contemporary botanists, which we would not willingly lose. A few letters to the late Mr. Lambert, Vice President of the Linnæan Society, are followed by a more extended series addressed to Dr. Darlington himself. These form, in our estimation, the most characteristic part of the volume; as they have the vivacity, simplicity, and freshness, and consequently the lively interest, which belong only to letters addressed to a familiar friend, without the remotest idea of their being seen by a third person. The series, too, embraces the later and most interesting portion of the writer's life; the last year of his residence in Florida, (1817); his cruise in the U. S. frigate Congress, with the government commissioners sent to Buenos Ayres, Montevideo, &c., for the purpose of ascertaining the condition and prospects of the South American colonies, then struggling to establish their independence; his return to Wilmington, Delaware, where his time was chiefly occupied in preparing for publication, at Dr. Darlington's request, a set of spirited articles, entitled "*Notices of East Florida and the sea coast of the State of Georgia, in a series of letters to a friend in Pennsylvania*," filled with valuable observations upon the condition, resources, productions, and botany of that country, but which unfortunately were left half finished when he was called to join the expedition under Major Long: still the fragment which the editor has introduced at the close of the volume, will be read with great interest. From the latter part of the correspondence with Dr. Darlington, we gather many data respecting the origin and early progress of Long's expedition, which appears to have been attended with the usual amount of bad management, vexation, and disappointment. One item of the instructions from government might perhaps have been advantageously copied on a more recent occasion, viz. that in which the commander and journalist are instructed "*not to interfere with the records to be kept by the naturalists attached to the expedition.*" But Dr. Baldwin's health was totally unequal

to the undertaking in which he embarked with characteristic enthusiasm. The victim of pulmonary disease, "his strength failed him ere the expedition was fairly under way; and he died at Franklin, on the banks of the Missouri, on the first day of September, 1819, in the forty-first year of his age. His gentle spirit forsook its frail tenement in a region far remote from his anxious family, and the wild flowers of the west, for more than twenty years, have been blooming on his lonely grave; but the recollection of his virtues continues to be fondly cherished by every surviving friend; and his ardor in the pursuit of his favorite science will render his memory forever dear to the true lovers of American botany."

We had intended to extract a large part of the editor's neat and concise biographical sketch, and especially to make some selections from the correspondence; but we fear that we have already exceeded the limits of a bibliographical notice. Were we allowed a single extract, our choice would fall upon pages 215–216, relating to the Indians of Florida and Georgia, and the treatment they have received. In his love and sympathy for these children of the forest, Dr. Baldwin forcibly reminds us of his predecessor, William Bartram, (to whom, by the way, he paid a visit in 1817, of which a pleasing notice is given on p. 238.) The latter enjoyed the hospitality of these tribes in their palmy days. The indignant epistle of Baldwin describes and denounces a course of policy which he observed in full operation, and which, in less than thirty years, has wrought out the predicted result. But we must abruptly conclude our desultory remarks with the expression of our thanks to Dr. Darlington, for this worthy tribute to the memory of a most zealous botanist, and very important contribution to the history of the *amiable science* in this country. A. Gr.

2. *Cours élémentaire de Botanique;* par M. Adrien de Jussieu, Professeur au Muséum d'Histoire Naturelle, etc. etc. Paris. Part I. pp. 226, 12mo.—This treatise forms a part of an elementary course of natural history, for the use of the colleges and other schools in France, prepared in conformity with a *programme* of the Council of Public Instruction on the 14th of September, 1840, and which consists of three small volumes; that on Zoology by Milne Edwards; that on Mineralogy and Geology by Beudant; while the botanical portion was confided to the hands of the son of the immortal author of the *Genera Plantarum*, and his successor in the professorship at the Royal Museum of Natural History. The first part of the volume only has yet appeared, and is devoted to the *Organs and functions of vegetation, or nutrition.* It includes, however, a very interesting chapter upon *Inflorescence*, a subject which would seem rather to belong to the system of reproduction, but which is very naturally introduced in connection with the chapter on

ramification. The author does not hesitate to discuss, in this elementary treatise, most of the questions which are now exciting the attention of physiologists; such as the development of the simple tissues, the nature of the endogenous structure, the doctrine of phyllotaxis, cyclosis, intercellular rotation, etc. We await with much interest the appearance of the second part of this excellent introduction to botany.

A. Gr.

3. *Grundzuge der Botanik, entworfen* von Stephan Endlicher und Franz Unger. Vienna, 1843. pp. 494, 8vo.—In the production of this admirable text-book, one of the most accomplished systematic botanists of the age has been joined by his friend, a distinguished physiologist. The work is divided into two parts; the first treating of the nature of plants as individuals; the second, of plants viewed as composing a systematic unity, a vegetable kingdom. The first part comprises, 1st, Histology, or an account of the elementary organs of plants; 2d, Organology, corresponding to organography; and 3d, the Physiology of plants; and is illustrated by 450 figures on wood. The most interesting portion, in the present state of vegetable morphology, is the chapter on the *gynæcium*, in which Endlicher, who, it is well known, early adopted the *axile theory of placentation*, has here applied it in detail to the various forms and modifications of the ovary. The chief advantage of this theory is, that it harmonizes in the simplest manner the laws of placentation with the general law which regulates the production of buds. It appears to be the prevalent theory on the continent, and might have been generally adopted, had it not met with so formidable an opponent in Mr. Brown, the person best qualified to decide such questions, and who has brought against it the most direct and apparently unanswerable arguments. In the second part of the work, we have, firstly, a brief exposition of the fundamental principles of Systematic botany. This is followed by a chapter on Geographical botany, which treats of the propagation and distribution of plants over the earth's surface, and of the causes which control this distribution; such as the temperature of the air and of the earth, the humidity of the air, the constitution of the soil, &c.; and finally, we have an enumeration of the twenty-five districts of vegetation, and their characteristic forms, as proposed by Schouw. Lastly, an interesting chapter is devoted to the history of the vegetable kingdom, or the mutations which plants have undergone in time, whether in remote geological periods, or since the creation of man, from causes still in action. A. Gr.

4. *Lehrbuch der Botanik;* von Dr. G. W. Bischoff, Prof. Bot. Univ. Heidelberg. Stuttgart, 6 vols. 8vo, with 16 plates in 4to, 1834–1840. —This elaborate manual forms a part of the *Naturgeschichte der drei*

Reiche; a series of natural history text-books, prepared by Professors Bischoff, Blum, Bronn, Leonhard, Leukart, and Voight. The first three volumes of Prof. Bischoff's work are devoted to *General botany;* under which he treats, 1st, of the external conformation of plants, or Organography; 2d, of their internal, or anatomical structure, Phytotomy; 3d, of their chemical composition, or vegetable chemistry; 4th, of the phenomena of vegetable life, under normal conditions, or vegetable Physiology; 5th, of these phenomena in abnormal conditions, or vegetable Pathology, under which head is considered not only the diseases, but also the monstrosities of plants; 6th, of their distribution over the earth, or Geographical botany; 7th, of the origin of plants, and of the changes which the vegetable kingdom has undergone in the lapse of time, i. e. the history of plants; 8th, of the mutual relations or affinities of plants, and the principles of their scientific arrangement, or Systematic botany and Phytography; and 9th, the history of botany from Theophrastus down to A. D. 1838. To each division is appended a very complete and useful list of the works upon that department of the science. The fourth and fifth volumes, entitled *Special Botany*, are occupied with a very full exposition of the natural system, as disposed by Bartling; in which the characters of the orders and other leading divisions are given in detail, and the most important genera and species popularly described. The last volume, or appendix, contains the Glossology of the science in the form of a dictionary; the Latin terms in the first part being explained in German, while in the second the German technical terms are defined by their Latin synonyms. A. Gr.

5. *Grundriss der Botanik, zum Gebrauche bei seinen Vorlesungen;* von Georg Fresenius, M. D., &c. Ed. 2. Frankfort, 1843. pp. 90, 8vo.—This brief sketch of the science comprises the "ground-work" of Dr. Fresenius' botanical lectures, and is chiefly designed as a text-book for his class. It treats, first, of the chemical elements of plants, then of their organography in the ordinary course, and finally, of their systematic arrangement; giving under the latter head a conspectus of Jussieu's, De Candolle's, and Endlicher's several modes of distributing the natural orders. A. Gr.

6. *Buek's Index generalis et specialis ad A. P. De Candolle Prodromum Syst. Nat. Reg. Vegetabilis, &c.*—The second part of this useful index of the genera and species in De Candolle's Prodromus, comprising the Compositæ, was published in 1840, and was duly announced in this Journal. But the first part, forming an index to the first four volumes of the Prodromus, appeared much later, viz. at the close of the year 1842, (forming 423 pages, 8vo.,) so that botanists are now furnished

with a complete index to that invaluable work, down to the first part of the 7th volume. We may here state, that the 8th volume of De Candolle's Prodromus was probably published at Paris in December last, and will doubtless reach us in season for a notice in the ensuing number of this Journal. A. Gr.

7. *Ledebour's Flora Rossica.*—The first part of this work, published in 1841, was announced in a former number of the Journal, (Vol. xliii, p. 188.) The second, published in 1842, comprises the natural orders from *Violaceæ* to *Geraniaceæ*, following the series of De Candolle's Prodromus. Much the largest family of this portion is the *Caryophyllaceæ*, especially the *Alsineæ*, which are here elaborated by their assiduous monographer, Dr. Fenzl, of Vienna, in such a manner as satisfactorily to clear up the doubts and obscurities that rested on many of our northern species. We hope soon to be able to announce the publication of Dr. Fenzl's complete revision of this family. The third part of the Flora Rossica, which completes the first volume, (of 786 pages,) was published in 1843, and has just reached us. It continues the series from *Balsamineæ* to the end of *Leguminosæ;* the latter being, of course, much the largest order of the Exogenæ Polypetalæ. The Russians are actively engaged in exploring their remote Asiatic provinces, but their American possessions do not appear to have been visited of late years by any botanist. Consequently, this work has thus far thrown very little additional light upon that portion of the flora of our own continent.
A. Gr.

8. *A Manual of British Botany, containing the Flowering plants and Ferns, arranged according to natural orders;* by Charles C. Babington, M. A., F. L. S., etc. London, Van Voorst, 1843. pp. 400, 12mo.—This new compendium of British plants is formed on the model of Koch's excellent *Synopsis Floræ Germanicæ*, (which we are glad to learn is now passing to a second edition.) The author has been highly praised for his knowledge and acumen, even by those who are far from agreeing with him in many of his conclusions respecting the validity of particular species. Mr. Babington found it necessary to make a careful comparison of the British with the continental flora; "for it appeared that in very many cases the nomenclature employed in England was different from that used in other countries, that often plants considered as varieties here, were held to be distinct species abroad, that several of our species were looked upon only as varieties by them, and also that the mode of grouping into genera was frequently essentially different." This state of things the author conceives to be the result of the long-continued interruption of scientific intercourse between England and

the continent during the war with France, and the firm establishment of the Linnæan artificial system consequent upon the great popularity of Smith's Flora of Britain, &c. "At the conclusion of the war," says Mr. B., "we had become so wedded to the system of Linnæus, and it may even perhaps be allowable to add, so well satisfied with our own proficiency, that, with the honorable exception of Mr. Brown, there was at that time scarcely a botanist who took any interest in, or paid the least attention to the classification by natural orders, which had been adopted in France, and to the more minute and accurate examination of plants which was caused by the employment of that philosophical arrangement. * * * * The publication of so complete and valuable a Linnæan work as the *English Flora*, greatly contributed to the permanency of this feeling; and accordingly we find that, at a very recent period, working English botanists were unacquainted with any of the more modern continental floras, and indeed, even now, many of those works are only known by name to the great mass of the cultivators of British botany." The author has adopted Koch's plan of distinguishing the essential and diagnostic portions of the specific characters by italic type, which thus strike the eye at a glance. The author, or, perhaps we should say the printer, seems quite undecided whether to write specific names derived from persons with a small initial, as recommended in the report of the committee on nomenclature to the British Association; or with a capital initial, according to common (and proper) usage; for in this manual both modes are followed in about an equal number of cases. A. Gr.

9. *Kunze's Supplemente der Reidgräser* (*Carices*) *zur Schkuhr's Monographie*, &c. Part 3d, (Leipsic, 1843.) Plates 21—30.—The third part of Prof. Kunze's valuable continuation of Schkuhr's Carices contains good figures of the following North American species; viz. *C. rufina*, Drejer; *C. nardina*, Fries (=C. Hepburnii, *Boott. in Hook.*;) *C. subspathacea*, Hornem. (=C. bracteata, *Giesecke?* C. salina, var. *Wahl.* C. Hoppneri, *Boott.*;) *C. Wormskioldiana*, Hornem. (=C. Michauxii, *Schweinitz*;) *C. Careyana*, Dewey; *C. æstivalis*, M. A. Curtis; and *C. stylosa*, Meyer (=C. nigritella, *Drejer.*) We also learn that the well-marked *Carex stenolepis* of Torrey must needs bear the name of C. Frankii given by Kunth; as there is a prior *C. stenolepis* established by Lessing (*Reise durch Norwegen, etc.*) so long ago as the year 1831; although Kunth does not mention it in his Cyperographia, published six years later. As if to increase the confusion of synonymy, we find that the name of this species is changed to *C. Shortii* in Steudel's *Nomenclator Botanicus, ed.* 2, the anterior C. Shortii of Dewey being omitted.—It may be remarked that Dr. Knieskern has lately

rediscovered *C. Barrattii* in New Jersey, and that it proves to be identical with the European *C. flacca* of Schkuhr. We may also take this opportunity to state that *C. miser* of Mr. Buckley, described in this Journal, Vol. XLV, p. 173, is probably identical with the *C. juncea*, Willd., described from specimens cultivated in the Berlin Botanic Garden, the particular derivation of which cannot now be traced. A. GR.

10. *Botanische Zeitung.* (Berlin, A. Forstner. Subscr. $4\frac{2}{3}$ Pruss. thalers per annum.)—This interesting botanical newspaper, which commenced in January, 1843, is most ably conducted by Prof. Mohl of Tübingen, the distinguished vegetable anatomist, and Prof. Von Schlechtendal, the well-known editor of the Linnæa. It is occupied with original articles upon vegetable anatomy, physiology, morphology, and systematic botany, and with brief but spirited reviews or critical notices of new publications, accounts of the proceedings of learned societies, and general botanical news.

As this weekly gazette embraces within its scope the matter formerly given in the *Litteratur-Bericht* of the *Linnæa*, the supplementary department of that journal is now discontinued, and, having completed the 16th volume, a new series is commenced, under the slightly modified title of *Linnæa, ein Journal für die Botanik, etc.; oder Beitrage zur Pflanzeukunde.* A. GR.

11. *Prof. Forbes's Bakerian Lecture.*—We have received from the respected author, and perused with much interest, the lecture of Prof. Forbes of Edinburgh, "On the Transparency of the Atmosphere, and the Law of Extension of the Solar Rays in passing through it." Efforts have been made from time to time by eminent meteorologists, to determine the proportion of the sun's heat absorbed in passing through the atmosphere, (a subject like that of atmospheric refraction, of great importance to the most refined astronomical inquiries,) and the resources of geometry have been combined with direct experiments, to ascertain the law of extinction of the solar rays in passing through successive strata of the atmosphere. But a more promising mode of establishing this law, and of ascertaining the actual amount of loss of solar heat from atmospheric absorption, is by simultaneous observations of the comparative intensities of solar heat at different altitudes. Sir John Herschel's actinometer supplied the instrument best adapted to such observations. Furnished with several of these instruments, accompanied by minute instructions from the illustrious inventor, Prof. Forbes resorted to the *Faulhorn*, a high and insulated mountain of Switzerland, extremely well adapted to the purpose. He had the good fortune to associate with himself Prof. Kämtz of Halle, likewise an accomplished

experimenter, and intent on meteorological inquiries. Furnished with every variety of instruments that could contribute to insure accuracy, the observers stationed themselves, the one at the summit of the mountain, and the other at its base, the difference in altitude being six thousand eight hundred and forty four feet, and therefore comprising nearly one fourth of the whole weight of the atmosphere. Their observations were prosecuted for a number of days during the month of September, under favorable circumstances, and the following *conclusions*, among others, were fully established:

That, on the hypothesis of uniform opacity, a standard atmosphere of 29·922 inches, having a mean dampness or ratio to saturation represented by ·56 nearly, would transmit 68½ per cent., or stop 31½ per cent. of the incident heating rays;

That the absorption of the solar rays by the strata of air to which we have immediate access, is considerable in amount, even for moderate thicknesses;

That the tendency to absorption through increasing thicknesses of air, is a diminishing one; and that the absorption almost certainly reaches a limit beyond which no further loss will take place by an increased thickness of similar atmospheric ingredients; and that the physical cause of this law of absorption appears to be the non-homogeneity of the incident rays of heat.

12. *Memoirs of the Chemical Society of London for* 1841, '42, *and* '43. Vol. I. R. & J. E. Taylor, London, 1843. pp. 258, 8vo. With the *Proceedings of the Society* for the same period. pp. 64, 8vo.

This valuable volume is the first fruits of the Chemical Society established in London in 1841. It contains forty two articles from twenty nine different authors, among whom are many of the most eminent chemists in England, and several names of high renown on the continent; of the former we may mention Drs. Ure, Graham, Johnston, Gregory, Playfair, &c. &c., and from the continent, Liebig, Bunsen, Stenhouse, Will, &c. &c.

Dr. Playfair's article on the milk of the cow, is a very interesting one, and valuable in a practical point of view, as indicating the best modes of feeding cows, and showing the changes in composition of the milk of a cow according to its exercise and food. Dr. Gregory gives a new method for obtaining pure silver from the chloride, by treating the latter, *while still moist*, with a strong solution of caustic potash, (sp. gr.=1·25,) enough of which is added to cover the chloride half an inch in depth, and then boiled; the chloride is thus all speedily converted into brown oxide of silver, which is washed with hot water to remove chloride of potassium, and is then either kept as oxide of silver

or fused with a little carbonate of potash. Metallic silver, perfectly pure, is thus obtained with great ease and rapidity. The oxide of silver thus prepared we have used to dissolve in cyanide of potassium, for the purposes of the electro-metallurgist, with entire success.

Prof. Liebig has a very important paper on the preparation and uses of *cyanide of potassium*, a salt now of great value from its employment in gilding and silvering in the moist way, and recommends the following process. The yellow prussiate of potash is dried (until it falls to a white powder) on a hot iron plate, and then mixed with dried carbonate of potash in the proportion of 6 oz. of the latter substance to 16 of the former, and the mixture thrown at once into a Hessian crucible previously heated to redness, and kept at that temperature until the mixture is completely fused with lively effervescence. It is stirred with a glass rod, and when it has a clear amber color is taken from the fire; the brown flocks of matter (which are *metallic iron*) seen floating about in the liquid mass settle, and the clear fluid is poured on a marble slab, broken up, and it is fit for use. The reaction which takes place in this process gives us a portion of cyanate mixed with the cyanide, which interferes with no one of its uses. Liebig remarks that it is difficult to conceive with what extreme facility the cyanide of potassium deprives certain metallic oxides and sulphurets of their oxygen and sulphur, for of all known substances, it approaches nearest in that respect to pure potassium. He then describes the use of this salt as an agent in quantitative analysis, where it renders easy, many before difficult processes.

13. *The Encyclopædia of Chemistry, Theoretical and Practical, presenting a complete and extended view of the present state of Chemical Science;* by JAMES C. BOOTH and MARTIN H. BOYE. Philadelphia; Carey & Hart. 8vo, published in numbers, with plates and wood cuts. Nos. I and II.—This work is understood to be founded mainly on the celebrated Chemical Dictionary of Liebig and Wöhler, while it contains all that is most valuable in Ure and other English writers. The well known accuracy and knowledge of its conductors, is a sufficient guarantee for the value of the work.

It abounds in information useful to the manufacturer and artisan, and yet contains much to command the attention of the chemical student. We have read with much satisfaction the article on Affinity. Under Acids is a full table of organic and inorganic acids, with their sources, formulæ and authority. The tables under Alcohol are more full and varied than can be found elsewhere in our language, and the entire article under that head is most excellent, while the article on *Agriculture* embodies in a condensed form a great amount of valuable matter, em-

bracing the new views on that subject. The several mineral species are given under their alphabetical heads, with their most important characters and analyses.

When finished, this work will be a most complete and valuable storehouse, well arranged for reference, into which one cannot look without finding something suited to his purpose. This edition is published in numbers, twenty-four of which will complete the volume. Each number contains about sixty-four pages of close type, at the remarkably small price of twenty-five cents each.

14. *Mr. Alger's edition of Allan's Phillips' Mineralogy.*—Mr. Alger has been for some time engaged in preparing for the press a new edition of Mr. Phillips' popular treatise on mineralogy, taken from the last English edition by Allan. Much new matter and about fifty new figures have been added to the "Introduction" on Crystallography, besides many new original figures of species and new measurements of angles. The new and modern analyses of old species have been in many instances substituted for those of Vauquelin and Klaproth; while many new analyses have been made for this edition by Mr. Hayes of Roxbury, Dr. C. T. Jackson and Mr. John H. Blake of Boston.

We understand that this volume, which is nearly all printed, will be published about the middle of April next. On its appearance we shall notice it again.

15. *Proceedings of the Boston Society of Natural History, taken from the Society's Records.* 8*vo*, *Boston*, *pp.* 128, *from Jan. 6th*, 1841, *to June 21st*, 1843.—This active society, whose useful labors have frequently been noticed in our pages, has commenced the regular publication of its proceedings. The abstracts of papers are ably reduced, and show that the society has an uncommon number of *working resident* members, as well as active correspondents. We have no room to quote *all* the passages which we had marked for extraction, in these "proceedings." On p. 101, Mr. Teschemacher makes an interesting communication on the origin of the valuable manure called Guano, from the sea islands off the coast of Peru. We extract the passage.

"With reference to the opinion, entertained by some, that the Guano had been accumulating from a period perhaps prior to the origin of the human race, Mr. T. translated the following passage from the 'Memoriales Riales' of 'Garcilasso de la Vega.' Lisbon, 1609, p. 102. 'On the sea-coast, from below Arequipa as far as Tarapaca, which is more than two hundred leagues of coast, they use no other manure than that of marine birds, which exist on all the coast of Peru, both great and small, and go in flocks perfectly incredible, if not seen. They are reared

on some uninhabited islands which exist on that coast, and the manure that they leave is of inconceivable amount. At a distance the hills of it resemble the mounds on some snowy plain. In the time of the Incas there was so much vigilance in guarding these birds, that, during the rearing season, no person was allowed to visit the islands under pain of death, in order that they might not be frightened and driven from their nests. Neither was it allowed to kill them at any time, either on or off of the islands, under the same penalty.' Each district or territory also had a portion of these islands allotted to it, the penalties for infringement of which were very severe. From this extraordinary care it is probable that the Incas did not permit any remarkable consumption of this valuable manure beyond the annual additions; and the consumption during the depopulation of South America by the Spaniards could, by no means, have equalled those annual deposits. Even the greatest thickness of seven to eight hundred feet might, without extravagant calculation, be deposited in about three thousand years at the rate of two or three inches a year. The feathers do not appear different from those of birds of the present day. Mr. Blake, a member of our society, who has visited these deposits, has a shell found in the Guano, very much resembling the *Crepidula fornicata* of this coast, but not in any way fossilized. On this coast it never rains, so that the deposits of manure are not, like those on other coasts, annually washed away."

We have just received the new number of the society's Journal, containing several interesting and valuable papers, particularly on the ichthyology of the North American lakes, by Dr. J. P. Kirtland, and on the fishes of Brookhaven, L. I., by Mr. Ayres.

16. *Proceedings of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge.* Vol. III, (celebration of the hundredth anniversary.)—We have already given (Vol. XLV, page 231) a list of the papers read before the American Philosophical Society on the occasion of its hundredth anniversary in May last. This stout pamphlet of 228 pages contains excellent abstracts of those papers, mostly from the accurate pen of the reporter, (Prof. Bache.) Several of the most interesting papers read on this occasion have already appeared *in extenso* in our pages—e. g. by Messrs. Walker and Kendall, on the Great Comet of 1843, (Vol. XLV, p. 188;) by Mr. Redfield, on the Tides and Currents of the Ocean, (Vol. XLV, p. 293;) by Prof. Norton, on the Tails of Comets, (p. 104 of the present number.) Many of the geological notices have also appeared under various heads, and we shall probably have occasion to lay other valuable matter from the same source before our readers. The meeting was one of remarkable interest, and equally remarkable for the number of valuable original memoirs and discussions which it developed.

17. *Sketch of the Analytical Engine invented by Charles Babbage, Esq.* By L. F. Menabrea of Turin, Officer of the Military Engineers; with notes by the translator. (Extracted from the Scientific Memoirs, Vol. 3.) London, 1843.—It is well known that in 1823 the British government undertook to construct a calculating engine invented by Mr. Babbage. This machine was designed to compute and print off tables of many different kinds, particularly such as are wanted for the uses of astronomy and navigation. The calculations were to be performed by the successive addition of finite differences, a method which admits of rigorous exactness, only where all the differences after a certain order (in Mr. B.'s machine the seventh) disappear, but which in many other cases is able to furnish within certain limits results accurate enough for every practical purpose. The construction of this machine, after ten years' labor and an expenditure of £17,000, was discontinued in 1833, and has never since been resumed. Shortly after this interruption, Mr. Babbage conceived the plan of a machine essentially different from his first, possessing all its powers, and others vastly more important; which, instead of being confined to arithmetical addition, should be able to add, subtract, multiply, divide, calculate powers and roots, in any required order of succession, and in strict obedience to the laws of algebraical combination. Of this stupendous invention Mr. Menabrea has given us an account, remarkable for its clearness, and, so far as it goes, satisfactory. Avoiding all detail, he presents in distinct though general outline, the plan of the machine, and its mode of operation. Much valuable information and explanation are supplied by the copious notes of the translator.

MISCELLANIES.

DOMESTIC AND FOREIGN.

1. *Dr. Percival, the original observer of the crescent-formed Dykes of Trap in the New Red Sandstone of Connecticut.*—At the last meeting of the Association of American Geologists and Naturalists, held at Albany, in May, 1843, a discussion arose on the *cause* of the crescent form observed by Dr. Percival in the trap dykes of the Connecticut sandstone, and by Prof. H. D. Rogers in the same formation in New Jersey. A condensed summary of this discussion is given on page 334, Vol. XLV, of this Journal.

Prof. Rogers introduced his remarks by saying, that his attention had been arrested on examining the singularly accurate and beautiful map by Dr. Percival, published in his Report on the Geology of Con-

necticut, by the fact, that the points of the crescents in that State were all turned in a generally southwest direction, the dip of the strata being northeasterly; while on the contrary in New Jersey, the opposite direction was observed both in the dip and the points of the crescents. In the abstract referred to, desiring to make the matter as condensed as possible, consistently with clearness, I left out the above allusion to Dr. Percival's report, and the fact, (well known to all acquainted with New England geology,) that Dr. Percival was the *original observer* of this important feature in our trap system, and confined the report simply to a concise statement of the outlines of the *theory* proposed, to account for the form observed, taking the fact and the original observation to be well known. I have been informed since the appearance of this abstract, that it wears a coloring of injustice to Dr. Percival, as the *original observer of the facts*, and their most acute and laborious expounder—since no reference was made to him in the report alluded to. Nothing could have been farther from my thoughts and intentions, than any shadow of injustice to Dr. Percival; but I freely acknowledge, that on a second perusal of the discussion in question, I can see that it would have been better to have made the allusion to Dr. Percival's discovery, contained in the first part of this note.

Meantime I would say, that it is a subject of much regret with all who are interested in the question, that Dr. Percival has not given us his theoretical and practical views on this subject, in a shape more enduring and extended, than casual conversation with his scientific friends, and verbal communications to the Connecticut Academy of Arts and Sciences.* In his very accurate Report already alluded to, Dr. Percival has felt obliged to confine himself almost entirely to the facts observed, and has dealt very sparingly in those general conclusions which might very legitimately be drawn from them, and which he is so able to give. It is our intention to insert in an early number of this Journal, a review of Dr. Percival's Report, and to accompany it by the map of the district examined, from which geologists can form a better notion of the subject of the present note. B. Silliman, Jr.

Yale College Laboratory, New Haven, Dec. 25, 1843.

2. *Method of separating the Oxides of Cerium and Didymium;*† by L. L. Bonaparte.‡—I had been for some time occupied with the study of several metallic valerianates,§ especially that of the oxide of cerium,

* The earliest of which was communicated to this society, Dec. 25, 1834.

† From διδυμος, *twin*.

‡ Translated from Poggendorff's Annalen, Vol. lix, p. 623. The original appeared in the Comptes Rendus, T. 16, p. 1008.

§ Valerianic acid is obtained from the roots of *Valeriana officinalis*. It forms a large and well characterized class of salts with metallic oxides.—*Eds.*

when I became acquainted, through the medium of the scientific journals, with Mosander's discovery of didymium.* It has been my good fortune to discover, in a concentrated solution of valerianic acid, the means of separating the oxide of cerium in a state of purity. Valerianic acid possesses a remarkable and unexpected affinity for the oxide of cerium, inasmuch as it precipitates it abundantly from a concentrated solution in nitric acid, containing at the same time oxide of didymium. The yellowish-white precipitate consists merely of the valerianate of the oxide of cerium, and it is only requisite to wash it well and to submit it to a strong heat without exposure to the air, to obtain the oxide of cerium in a state of purity. This oxide is of a very pale yellow color, similar to that oxide as prepared by Mosander, who however confesses that he has not hitherto succeeded in discovering a method of separating from each other completely the oxides of cerium, lanthanum and didymium.

The oxide of didymium remains in solution in the acid fluid from which the oxide of cerium has been precipitated. A portion of the latter oxide remains, however, associated with that of didymium; for the valerianates of both these metals are to a certain extent soluble in water, and even more so in acidulated fluids, the oxide of didymium especially, which is far more easily soluble in weak acids than that of cerium. By means of valerianic acid, however, the oxide of didymium may be obtained in a state of purity, though not so readily as the oxide of cerium.

I have only to remark, in conclusion, that to obtain the valerianate of the oxide of cerium in a state of purity from the nitric solution of the mixed oxides of cerium and of didymium, this salt must be precipitated by an aqueous concentrated solution of valerianic acid;—with a soluble valerianate the didymium would be thrown down at the same time, inasmuch as the latter, when in the form of a valerianate, is but sparingly soluble in neutral solutions. It is therefore upon the ready solubility of the valerianate of the oxide of didymium in acidulous solutions, and upon the inferior solubility of the analogous salt of the oxide of cerium, that the simple preparation of the oxide of cerium in a state of purity is based.

3. *Sillimanite and Monazite.*—These two minerals which are associated in the localities at Norwich and Chester (Saybrook) in Connecticut, have recently been found together in a quarry in Yorktown, Westchester County, N. Y., by Mr. I. Mekul. They are there associated with *magnetic iron* and *quartz*, and the crystals of *Sillimanite* often penetrate this mineral for several inches. Mr. M. remarks, in a letter to me dated Nov. 21, that they are frequently six or more inches in length, much

* American Journal of Science, Vol. xliii, p. 404.

bent and fractured, as they are at Norwich and Chester. The *Monazite* from this locality is in very perfect, transparent prisms, with a simple pyramidal termination; they are small, rarely exceeding one eighth of an inch in length, and are scattered like small garnets through the brown quartz adjoining the *magnetic iron*. I have seen none of them *in* the latter gangue. As the Yorktown quarry is to be worked for the *iron*, we may hope for a supply of these two rather rare species.

In 1841, Mr. Arthur Connell* published an analysis of *Sillimanite*, from which he was led to associate this species with *disthene* (*kyanite*); his analysis substantially confirms Mr. Bowen's,† and the two are certainly inconsistent with that of Dr. Thomson's,‡ in which zirconia was found to be so large a constituent, (18 per cent.) Yet it is singular that in the analysis of Dr. Thomson's pupil, (Mr. Muir,) the sum of the silica, alumina, and zirconia, (=92·86,) should have so nearly equalled the silica and alumina in Mr. Bowen's analysis, 96·777. As small *zircons* are not uncommonly found associated with *Sillimanite* at Norwich, (although I have never seen them at Chester, from whence Dr. Thomson's specimens, and Mr. Connell's, were derived,) it is certainly possible that a portion of this species was mixed with the subject of analysis; otherwise it is difficult to understand what the mineral analyzed by Muir was. Among the specimens personally obtained at various times at Norwich, I have found one crystal with terminating planes, which, together with the characteristic diagonal cleavage of Sillimanite, is irreconcilable with the view of Mr. Connell—drawn from his own and Mr. Bowen's analysis—that this mineral is identical with disthene or kyanite.

B. Silliman, Jr.

4. *The great Telescope of the Earl of Rosse.*—We have been frequently indebted to our esteemed friend and correspondent, John Taylor, Esq. of Liverpool, for information respecting the progress of the largest telescope in the world. The following statement of facts respecting this telescope, is cited from the London News, illustrated, of Sept. 9, 1843, kindly forwarded to us by Mr. Taylor.§ It is now in progress at Parsonstown, Ireland, the seat of the earl of Rosse in King County, eighty seven miles from Dublin.

This nobleman appears to love science for its own sake, and in him talents of a high order are united with great perseverance and prac-

* Jameson's New Edinburgh Phil. Jour., Vol. xxxi, p. 232; entire No. 62.

† Am. Jour., Vol. viii, p. 113.

‡ Edinburgh Transactions, Vol. xi, 245, and Outlines of Mineralogy, Vol. i, 424.

§ The illustrations of various subjects in wood cuts are very beautiful, and every way worthy of being preserved in a more permanent form. A large portion of them are designed to immortalize the recent travels of the youthful British Queen and Prince Albert.

tical good sense. He has been working silently on, until the attention of the world is arrested by the magnitude of the result in the production of metallic reflectors of a size heretofore unknown. Until he demonstrated the contrary, it was thought impossible to cast a speculum of six feet in diameter. As a preliminary to his present gigantic work, there has been exhibited during the last ten or twelve years on the earl of Rosse's lawn, a reflecting telescope made by himself, with a mirror of three feet diameter, and a focal length of twenty seven feet. It is suspended by a frame-work similar, at least, if we may judge from the figure, to that of Dr. Herschel's great telescope.

Being in equilibrio, it is managed with the greatest facility. The casting, grinding, and polishing of these specula, and the machinery of the tubes and their suspension, were all accomplished under his lordship's eye and by his own direction. According to lord Rosse's experience, the only metals that can be employed in forming specula, are copper and tin, and the proportions should be, tin 58·9, and copper 126·4, or very nearly 3 of tin and 7 of copper.

Of these metals, for his large speculum, he melted three tons in three cast iron crucibles—crucibles of this metal cast with their mouths upward having been found the best. Each crucible containing a ton of metal was placed in a distinct furnace, and for nineteen hours subjected to an intense heat. The crucibles were lifted by an immense crane from their furnaces, and at nine in the evening of April 18, 1842, without accident or delay, they simultaneously poured forth their glowing contents, a burning mass of fluid matter, hissing, heaving, pitching itself about for a minute, and then calmly settling forever into a monument of man's industry and skill. When the metal had settled, it was drawn by a capstan into a heated oven and built in, where it remained for sixteen weeks annealing. The great difficulty experienced in producing large reflectors is, that in cooling, the metal generally cracks; and when this does not occur, the number of holes often found in the solid mass renders it of no use. Lord Rosse has the merit of having overcome both of these difficulties in a manner hereafter to be described in a distinct work. By an ingenious combination of motions, lord Rosse effected the difficult object of producing a parabolic figure on a large scale. It required six weeks to grind the speculum to a fair surface. The grinding tools being covered with pitch and sprinkled over with crocus, answered for polishing—nothing else being necessary —some precautions being observed to prevent an unequal action.

The tube in which the speculum is to be mounted, is fifty two feet long and seven feet in diameter, sufficiently large to receive a platoon of soldiers. This tube is of wood hooped with iron; it was constructed in a long gallery over a range of outhouses, which were thrown down

to admit of its removal. It is expected that this enormous instrument will be moved about and regulated by one man's arm, and placed in its position with the greatest ease and certainty. The walls destined to support the machinery, are built exactly in the meridional line, so that the telescope which will lie between them will take in objects only as they pass the meridional line; they can be kept in view for half an hour on each side of the meridian. As already intimated, the speculum is six feet in diameter, and the focal distance is fifty two feet. It will render visible a portion of the moon of the size of a common house. Lord Rosse has erected an equatorial instrument, the largest ever constructed. It is eighteen inches in diameter, and by its peculiar mechanism, the truest ever used. It is stated, that Sir James South laid out seven thousand pounds in erecting one which did not answer, and was afterwards broken up.

5. *Third Comet of* 1843.—A telescopic comet was discovered, November 22d, 1843, at 1h. A. M., near the star γ *Orionis*, by M. Paye, an astronomer attached to the Royal Observatory, at Paris. Notwithstanding the clouds and vapors which impeded the view, the place of the comet was found to be as follows: Nov. 22, 1843, 14h. 44m. 11s. Paris mean time, R. A. 81° 5′; N. decl. 6° 56′. On account of clouds, the comet was not again seen until the 24th, when its position was accurately determined, as follows: Nov. 24, 1843, 17h. 14m. 43s. Paris mean time, R. A. 80° 50′ 42″; N. decl. 6° 30′ 35″;—the apparent right ascension having diminished seven minutes of arc within about twenty-four hours, and the north declination having also diminished twelve minutes. The nucleus of this comet is so distinct, as to permit very precise observations. From the nucleus faint trains of light diverge nearly opposite to the sun; the entire tail being about four minutes in length.

Dr. South adds that the comet was observed by him, at his observatory at Kensington. Seen through the large achromatic of 11·9 inches diameter, with powers of 150 and 300, the nucleus seemed not round, but elongated in the direction of the tail, which latter, after moonset, extended about eleven minutes of arc. It does not bear much illumination of the field, although it was easily found with an achromatic telescope of 2·75 inches aperture. Its approximate place, November 30, 1843, at 48m. 37s. after midnight, was in R. A. 5h. 21m. 37s. N. decl. 5° 34′ 32″, very near the star A *Orionis.*—*New York Journal of Commerce, from a London paper.*

6. *Remarkable Fulgurite.*—M. Fiedler presented to the Academy of Sciences a fulgurite remarkable for its size and preservation. We make

the following extract relating to the discovery of this "tube fulminaire." On the 13th of June, 1841, at 5, P. M., a storm arose up the course of the Elbe, passing over the sand hills which are covered with vineyards, on the right bank of that river, near the village of Loschwitz, one league from Dresden. Believing the lightning to have struck the pavilion in which Schiller wrote his Don Carlos, they ran to the top of the hill; but fifty steps before arriving at this building, a split support of a vine indicated that lightning had struck here. M. Fiedler gave notice to the proprietor of the vineyard, remarking with surprise the near proximity of a plum tree, which he supposed from its height would have sooner attracted the electric fluid. Be that as it may, on tracing the direction of the fulgurite, they saw that it forced itself into the earth at an inclination of 66°; it met some small roots of the plum, which though containing more moisture than the surrounding gravel, and running in nearly the same direction with the electric spark, (as could be seen in the specimen before the Academy,) were only blackened in the parts surrounded by the tube and immediately contiguous—the heat, though enormous, having passed too suddenly to carbonize the wood. At one metre from the upper part, the fulgurite is divided into three long branches, each about sixty-five centimetres. It was stated on the spot, that these roots disappear in a bed of very moist argillaceous and ferruginous sand.—*Comptes Rendus*, 31*st July*, 1843.

7. *Upon the deposit of Gold recently discovered in the Ural.**—The mass of gold recently discovered in the Ural is the largest known in the whole world. It was found in the gold-bearing sands of Miask in the district of Zlatooust, not far from the celebrated mines of Tzarevo Nikolæfsk, and of Tzarevo Alexandrofsk in the southern Ural. These two mines which you have visited with so much interest, have already yielded as you are aware nearly 400 "pouds" of gold (6552 kil.) equal to about 17,544·5 lbs., and more than once very remarkable masses have been collected there. Thus in 1825 they found there the specimen weighing 24 phounds, 68 zolotniks (10 kil. 118,) about 27·017 lbs. However, these mines beginning to be exhausted, they were compelled to make explorations near the course of the river Tachkou-Targanka, which soon led to the discovery of a bed of gold-bearing sands of very great richness, but within very narrow limits. This bed once found, they turned off the stream, which had served for washing the sands, up the whole length of this river, and commenced their examinations in the dry bed of the stream. Their success was complete.

* Extract of a letter from M. de Kokcharoff, officer of the Royal Mining Company, to M. de Humboldt. Translated from the Annales des Mines, 4th series, tome 3, liv. 1, p. 51, 1843.

They came at once upon a stratum of gold-bearing sands of considerable extent, where the yield of gold was 100 pouds to 8 zolotniks, (a very great proportion, when it is remembered that sands giving 100 pouds to 1½ zolotniks have been before considered well worth exploring.) Then other beds were discovered of a yet greater capacity, which terminated in the examination of the whole valley of the Tachkou-Targanka, with the exception of the spot occupied by the buildings necessary for the washings. In the course of 1842 they pushed the works under the foundations of the building. The first attempts were not successful, but they soon came upon a spot of marvellous richness, where the yield was from 50 to 70 zolotniks of gold in one poud of sand. Its extent was however very limited. At last, on the 26th of October, 1842, they found this monstrous mass, weighing 2 pouds, 7 phounds, and 92 zolotniks, (36 kil. ·020758,) 100·078 lbs. It lay upon the strata of diorite* in the bed of gold sand, at the depth of 4½ *archines* from the surface and under the corner of the building.

The mass in question has already reached St. Petersburgh, and is placed at the museum of the Institute of Mining Engineers.† A discovery which is equally worthy of our attention, is that of a bed of gold-bearing sands on the left bank of the same river before the dike, containing a considerable number of masses; already they have taken thence 52, weighing each from one to seven pounds Russian.

Note by M. Humboldt.—The largest piece of platina found up to this time at Nijni Tageulsg weighs 20 lbs. (Russian), 34 zolotniks. Piece of gold found at Miask, 10 kil. ·119 = 27.002 lbs. Piece of gold found in the United States, Anson County, N. C. 21·70 kil. = 57·939 lbs. Piece found at Rio Hayna, (1502,) and lost in the depths of the sea, (see my critical examination of the geography of the new continent,) 14·500 kil. = 38·715 lbs. Wonderful mass of Miask found 1842, 36·020 kil. = 100·077 lbs.

According to a letter from Count Cancrine, Dec. 3, 1842, Siberia to the east of the Ural produced in 1842 the quantity of 479 pouds of gold = 7·846 kilogrammes = 21,058 pounds, and the whole of Russia about 970 pouds = 15·889 kilogrammes = 42,323·63 pounds.

8. *Periclase, a new mineral.*—M. Scacchi, professor of mineralogy at Naples, has communicated to the *Annales des Mines*, through his

* A variety of trap.

† According to Kupffer, (Travaux de la commission des mesures et des poids dans l'empire de Russie, 1811, tome 1, p. 331,)

1 kil. = 2 pounds Russian, 42 zolotniks and 40·54 dolei. Then 1 poud = 16 kil., 381; 1 pound Rus. = 0 kil. ·4095; 1 poud = 40 lbs. Rus.; 1 lb. Rus. = 96 zolotniks; 1 zolotnik = 96 dolei; 1 archine = 0^{m} 711.

friend, M. Damour, a description of a mineral found in the ancient lavas of Vesuvius, of a vitreous appearance, obscure green color, and confused crystallization, imbedded in a calcareous gangue like the gehlenite of Fassa. It cleaves readily in three directions parallel to the faces of a cube, whence it derives its name, Periclase. It crystallizes in regular octahedrons, is infusible before the blowpipe. The powder is entirely soluble in acids. Hardness equal to feldspar. Specific gravity 3·75. It is composed of magnesia and a little oxide of iron. Its composition in 100 parts, is

	First analysis.	Second analysis.
Magnesia,	92·57	91·18
Oxide of iron,	6·91	6·30
Insoluble matter,	·86	2·10
	100·34	99·58

Ann. des Mines, 4th Series, Vol. III, p. 369.

9. *Coast Survey.*—The death in November last of Mr. Hassler, the venerable and learned originator and conductor of the coast survey of the United States, left a vacant post, which has been filled to the universal satisfaction of the science of the country, by the appointment of Professor Alexander D. Bache as the successor of Mr. Hassler. No man in America could be found better qualified to carry through this great enterprise, combining as he does in an eminent degree the necessary scientific qualifications with great practical wisdom in the management of affairs and men, and possessing the unbounded confidence of all. It cannot be otherwise than gratifying to Prof. Bache, that he has been called to this post, as it were by the unanimous suffrages of his peers; for the entire body of science and learning in the country petitioned government for his appointment.

We understand that there is an intention of dividing the duties formerly performed by Mr. Hassler, and setting off the weights and measures in a separate department, over which is to be placed a gentleman eminently qualified to complete this subject, already in an advanced state.

10. *Canal around the Sault St. Marie to connect Lake Superior with Lake Huron.*—We observe that this important subject is agitated in Detroit, and that application is about being made to Congress for aid in effecting the work. The fall is twenty two feet, the length of the canal one mile, the estimated expense one hundred thousand dollars. An immense mining country, including the copper region, from which the great mass of native copper came, and which has now gone to Washington, lies around this vast fresh-water sea, whose length is be-

tween four hundred and five hundred miles, its breadth approaching one hundred and fifty miles, and its depth nine hundred feet.

It is in reference solely to the mineral, and other physical resources of the vast territory lying contiguous to its shores, that we feel it proper to mention the subject in this Journal, which has no relation to politics. We are free however to express our opinion that the general government ought at once to espouse this work, and give it a prompt and thorough execution, *at whatever cost.* It is due to the far west, to the near west, and even to the east, as the whole country is bound together by interests which justify and imperiously demand national aid to give them full activity, and thus to unite, by indissoluble ties, the most remote extremities of our immense empire—an empire which the people rule, and for the improvement of which the people are willing to pay.

11. *Destruction of the Public Conservatory at Boston.*—This valuable and beautiful collection of exotics, occupying a large circular domed conservatory, was totally destroyed by fire, which caught from one of the furnaces employed in heating the house; and although the flames were very soon extinguished, the escape of noxious gases and the entrance of cold air (14° F.) from without, soon ruined all that the house contained. This establishment was under the enlightened direction of Mr. J. E. Teschemacher, a gentleman whose scientific attainments are well known, and whose zeal in the department of horticulture and vegetable physiology, eminently qualified him for the post. He had at the time of the accident many interesting experiments in progress, especially on the subject of manures. The house contained the largest and most splendid plants of the Camellias and Rhododendrons in this country—the result of long years of judicious culture, and whose loss cannot soon be repaired. All the rare foreign birds in the conservatory also perished.

12. *The De Candolle prize for Botanical Monographs.*—The late Prof. De Candolle having bequeathed the sum of two thousand four hundred francs, in trust, to the *Société de Physique et d'Histoire Naturelle de Genève*, the interest of which is to be awarded, from time to time, as a premium for botanical monagraphs,* that society announces,

1. That, on the 9th of September, 1846, it will award a premium of five hundred francs to the author of the best monograph of a genus or family of plants.

2. The premium is open to the competition of all naturalists, without distinction, except the ordinary members of the society that holds the

* Vide American Journal, Vol XLIV, p. 23.

trust. Candidates are desired to transmit their memoirs, written either in French or in Latin, previous to July 1st, 1846.

The society will probably publish the monograph of the successful candidate in its Memoirs, (nine volumes of which have already appeared,) but does not pledge itself to do so.

13. *Effect of Electricity.**—My house was struck by lightning a few weeks ago, during a violent rain. The electric fluid followed a spout filled with water into a cistern, out of which a stream was flowing, thus affording a conductor to the earth. Yet the outer circumference of the cistern was torn into splinters, the fluid having passed outward through the staves. The largest splinters extended from one to another of the iron hoops of the vessel, which were slightly fused at a number of points.

14. *Proposed nomenclature of numbers between ten and twenty.*—The anomalous character of our nomenclature of the numbers between ten and twenty, has often been observed and lamented. It has been frequently seen to be a source of impediment to the young learner, and has often defied the skill of the more advanced to explain.

Several alterations have been suggested—such as "*one ten, two ten,*" for eleven and twelve—also, "*ten one, ten two, ten three,*" &c. Without enlarging upon the merits or demerits of these alterations, I will come directly to the one I wish to propose, which is, for eleven, twelve, thirteen, &c., to use *onety one, onety two, onety three,* &c. Aside from its novelty, there can be no more objection to abridging the expression one ten into *onety*, than that of two tens into twenty, three tens into thirty, &c. This alteration would bring the nomenclature of this decade into perfect analogy with that of the subsequent ones, and thus deliver the system from a great stumbling block of offense. D.

New Haven, Dec. 1, 1843.

15. *Heat from solid carbonic acid.*—There is a remarkable reaction between solid carbonic acid and the caustic alkalies. If a small piece of solid carbonic acid be wrapped in cotton with a little pulverized caustic potash, and the whole be pressed between the fingers, so much *heat* is evolved as to make it uncomfortable to hold. This is the most remarkable illustration of heat from chemical union. One of the agents employed is the coldest substance in nature, with which we are acquainted, that which we select to show the effects of extreme refrigeration. The other is at the natural temperature. Both

* Extract of a letter from S. S. Haldeman, Esq., dated Marietta, Pa., Sept. 15, 1843.

moreover are in the dry or solid state. Yet their union or simple contact produces heat, sufficient at least, to inflame phosphorus.

This reaction is noticed, as its suggests some striking experiments. It has very possibly been observed by others, though it is not referred to in various works on the subject. WM. F. CHANNING.

Boston, May 2, 1843.

16. *Death of Dr. Richard Harlan.*—This gentleman, whose papers have so frequently appeared on our pages, died at New Orleans, La., in October last, but of the particulars of his death, and his age, we know nothing.

17. *Death of Col. Trumbull.*—The venerable patriot, artist, and friend of Washington—the father of American historical painting—died at New York, Nov. 10, 1843, and was interred at New Haven in his own stone tomb, beneath the Trumbull gallery of pictures. (See Vol. XXXIX, of this Journal.) His autobiography was published two years ago, in a beautifully illustrated volume. He was nearly half through his 88th year.

18. *Death of the Rev. James H. Linsley.*—It is with sincere regret that we record the death of this amiable and excellent man, which took place on Tuesday morning the 26th of December, at his residence at Elmwood Place, Stratford, Conn., at the age of 56 years. Mr. Linsley was a clergyman of the Baptist persuasion, and continued in the active duties of his calling until about ten years since, when the failure of his health obliged him to seek other intellectual employment; and he found great solace and pleasure in a devoted attachment to the several branches of natural history, particularly ornithology, conchology, ichthyology and herpetology. His life was sustained by a beautiful enthusiasm, which carried him successfully through labors to which his bodily health was inadequate. How much he accomplished toward a knowledge of the natural history of his native state, may be judged of by referring to his papers published in this Journal. His last, on the Fishes of Connecticut, completed only a few days before his death was intended for our April number. His catalogue of the Mammalia of Connecticut, is in Vol. XLIII, p. 345; of the Birds, Vol. XLIV, p. 249; of the Reptiles, p. 37 of the present number.

Mr. Linsley has left extensive collections in several departments of natural history, besides valuable unpublished notes.